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Technology Review

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A SPECIAL ISSUE

MAKING SENSE OF THE PRODUCTIVITY DEBATE

▲
THE MIT COMMISSION REPORT

▲
NEW STRATEGY FOR A TROUBLED
INDUSTRY

▲
THE MILITARY'S INDUSTRIAL
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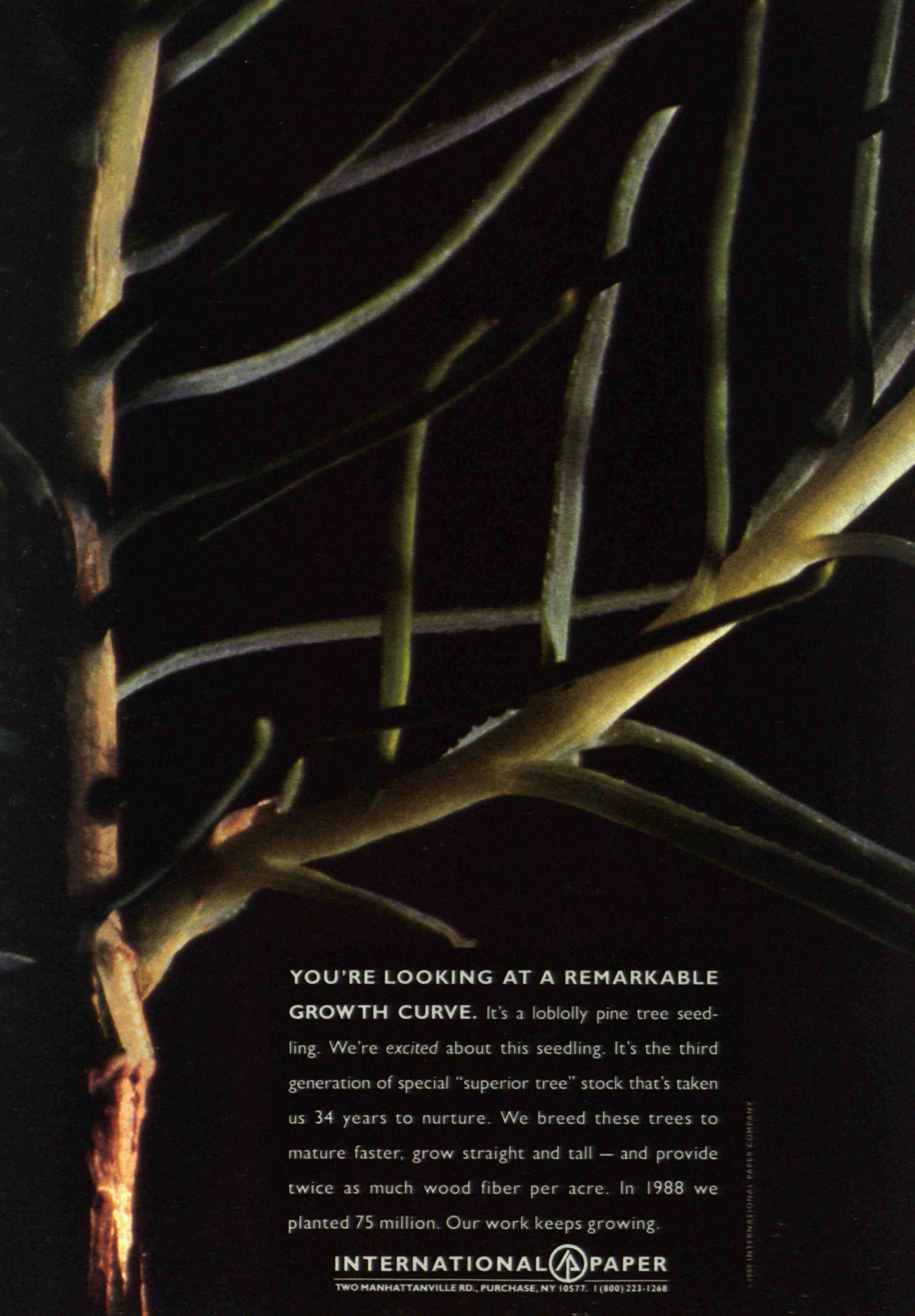
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RETRAINING THE WORKFORCE

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SPECIAL ISSUE: PRODUCTIVITY



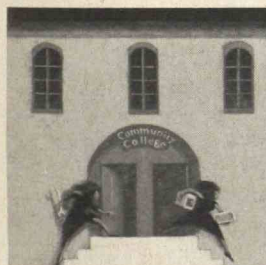
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FIRST LINE

FROM THE EDITOR

Productivity and Society

THE ancient Egyptian who created a plow by modifying a hoe and yoking it between two oxen was able to plant perhaps four times more acreage per day. The extraordinary gain in productivity made possible by the use of animal power was crucial to the development of Egyptian civilization. But watering the plowed lands required an irrigation system administered by a central authority. Had rudimentary government not already developed, the technical invention of the plow would have been useless.

Social and technological innovation, it appears, are inextricably linked. Many *Technology Review* authors have accepted this assumption in their attempts to address concerns about U.S. productivity. Since the 1970s, the magazine has run articles examining (to mention only a few topics) how corporate structures affect innovation, the military's role in key industries, the organization of work on the shop floor, and the production systems of foreign countries.

Made in America: Regaining the Productive Edge (MIT Press, 1989), the recent report of the MIT Commission on Industrial Productivity, similarly takes a social view of productivity. Its publication seemed a good occasion for us to devote an issue to this subject. We have chosen four articles that we believe probe critical questions about productivity in considerable depth.

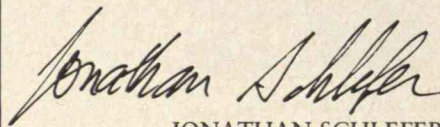
The first article in this issue, which I wrote, seeks to make sense of "the productivity problem," a phrase that has come to embody a myriad of interpretations. In the 1970s observers blamed sluggish productivity for high inflation. Now some blame it for increasing disparities between rich and poor, others say it doesn't affect the distribution of wealth, and still others say U.S. productivity is healthy. I identify several fundamentally different definitions of this thing called productivity and discuss where the MIT commission's report fits in.

Richard Kazis, building on his work for the commission, takes a close look at an unusual collaboration working to strengthen the U.S. fiber, textile, and clothing industries. The participants include apparel unions and traditionally anti-union textile firms, Harvard professors and sheep growers. Kazis believes that this may be a useful indigenous model of the kind of industry-wide collaboration that seems essential to productive growth in

other nations.

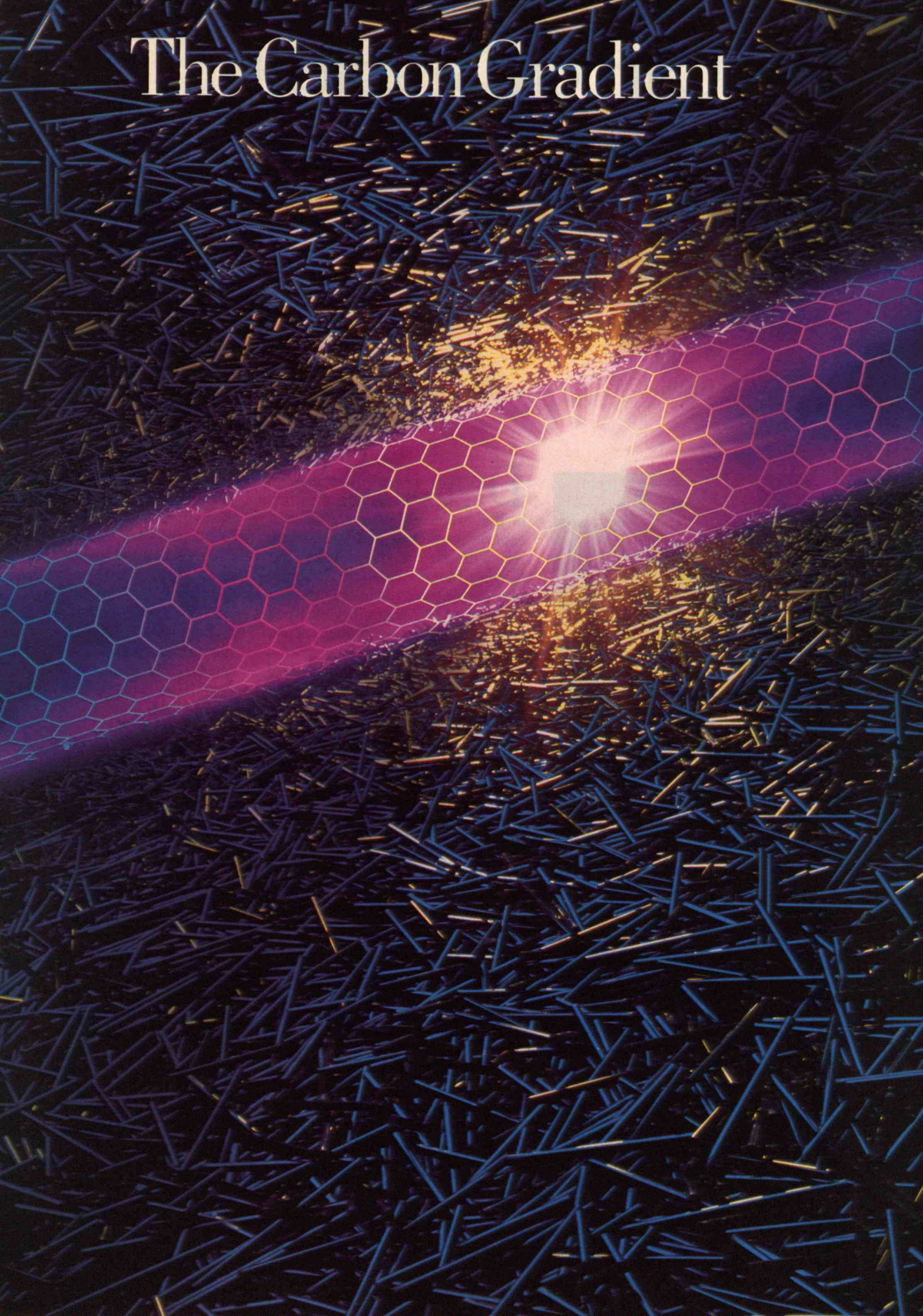
In an interview, Harvey Brooks and Lewis Branscomb of Harvard examine an issue that the MIT study skirted: the role of the military in U.S. manufacturing. This role has historically been central. The military has been credited with fostering technical advances from the manufacture of interchangeable parts in the nineteenth century to semiconductors in the 1950s and 1960s. Today, civilian spinoffs from military R&D appear to be declining. Brooks and Branscomb consider why and suggest how the nation should address this deep-seated institutional shift.

Much as Britain's educational system was blamed for the country's decline in the early twentieth century, U.S. education is a central concern today. It is well known that elite U.S. universities such as MIT are the envy of the world, and that our public schools appear to be in shambles. We decided to focus on community colleges, which offer promise for addressing the broad needs of U.S. education. James Jacobs of Michigan's Industrial Technology Institute discusses this uniquely American institution. The hope is that it can provide what the British educational system failed to: training in marketable skills that both grows from and contributes to genuine intellectual learning.



JONATHAN SCHLEFER

The Carbon Gradient



The Carbon Gradient

Hollow carbon filaments catalytically produced by submicron-size iron particles can be the template for larger carbon fibers used in composite structural materials. A scientist at the General Motors Research Laboratories has identified how these filaments grow and why they take their characteristic form.

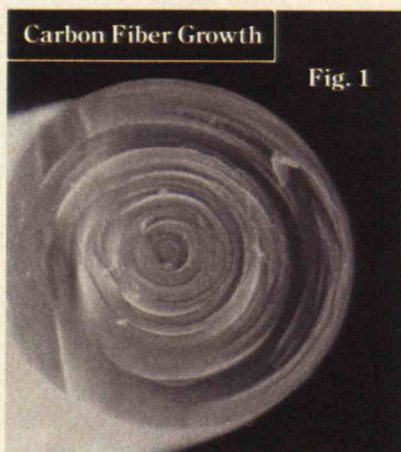


Fig. 1

FIGURE 1: Scanning electron micrograph of a cross section of a vapor-grown carbon fiber.

FIGURE 2: Typical carbon filament grown from natural gas by an iron catalyst particle.

FIGURE 3: Schematic model showing inner and outer radii, the precipitation interface, and the nested basal planes of the outer surface.

Dr. Gary Tibbetts was measuring the diffusion rate of carbon in iron when his carefully planned experiment took an unexpected turn. Dr. Tibbetts, a physicist at the General Motors Research Laboratories, had been introducing carbon to the inside surface of a hot stainless steel tube while extracting carbon from the outer surface.

At the end of one particular trial, he found the inside surface covered with a mass of black "whiskers." His initial investigations verified that the fibers were made of carbon and that they had characteristics typical of the crystal structure of graphite. But the question of how they formed was not so easily answered. The search for an answer would change the course of his investigation and dominate his research for the next ten years.

The fibers that surprised Dr. Tibbetts were made up of concentric layers primarily composed of basal (0001) plane graphite, resembling in cross section the annular rings of a tree (Figure 1). Research showed that they were formed by vapor deposition of carbon on a hollow central filament. The central filament itself was grown by catalytic action on a small metal particle (Figure 2).

These long, slender, uniform filaments had been widely observed since the availability of the electron microscope. Still, no valid explanation had been advanced to account for their hollow structure. Many scientists thought that surface diffusion of carbon-containing molecules around the catalytic particle caused the hollow core.

Instead, Gary Tibbetts proposed a model in which carbon atoms from decomposing hydrocarbons diffuse through the bulk of the catalytic particle and precipitate as graphite in the growing filament. The diffusion process is driven by the carbon gradient—the difference between carbon concentrations at the adsorbing surface of the particle and at its opposite, precipitating surface (Figure 3).

The exterior surfaces of these carbon cylinders expose the basal plane of graphite because the (0001) plane has a surface free energy at 970°C of about 77 erg cm⁻², while a typical surface perpendicular to the basal plane has a surface energy in excess of 4000 erg cm⁻². The free energy required for filament growth,

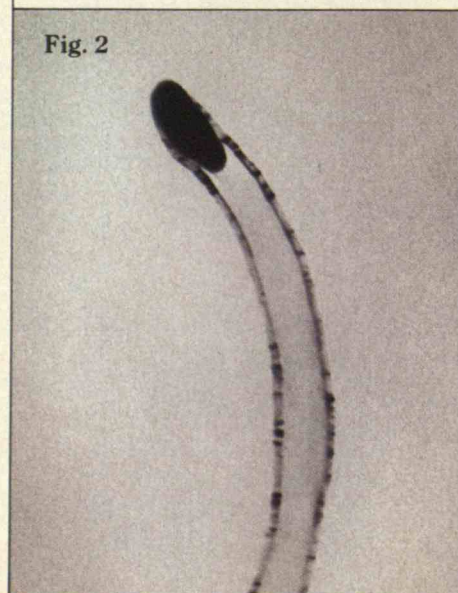


Fig. 2

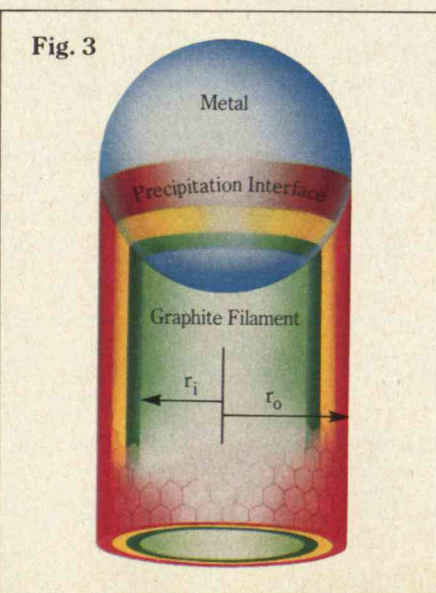


Fig. 3

therefore, will be a minimum when the exterior surface is made up of basal planes—as observed in these filaments.

The entire filament, then, should consist of nested, rolled-up basal planes of graphite. Bending these planes into cylinders, however, requires that extra elastic energy be provided during the precipitation process. The core is left hollow because too much energy would be required to bend the planes near the axis into very small diameter tubes.

In describing the total energy necessary for filament formation, Dr. Tibbetts' model takes into account the chemical potential change ($\Delta\mu_o$) when a carbon atom precipitates from the dissolved phase, as well as the energy required to form the surface, plus the energy needed to bend the basal planes into nested cylinders.

The change in chemical potential ($\Delta\mu$) driving the precipitation can be expressed as follows:

$$\Delta\mu = \Delta\mu_o - \frac{2\sigma\Omega}{r_o - r_i} - \frac{Ea^2\Omega}{12(r_o^2 - r_i^2)} \ln(r_o/r_i)$$

where σ is the energy required to form a unit area of (0001) graphite; Ω is the volume of a carbon atom in graphite; r_o and r_i are the outside and inside radii of the filament, respectively; E is the filament modulus; and a is the interplanar spacing.

A filament catalyzed by a particle of radius r_o will adjust its r_i to give the largest $\Delta\mu$ —in fact, r_i may be directly

calculated by maximizing $\Delta\mu$. Doing so yields results that compare nicely with experimental values.

Understanding the growth of the hollow core of the filaments was one key to producing them in abundance. "From there," says Gary Tibbetts, "it is a simple step to thicken the filament into a macroscopic fiber by vapor deposition of carbon on the exterior surface. The deposited carbon has a high degree of orientation parallel to the tube axis, giving the fiber exceptional stiffness.

"Fibers of this type should be excellent for making chopped-fiber composites using plastic, ceramic, metal, or cement matrices. GM's Delco Products Division is already building a pilot plant to develop a low-cost production process that would permit the use of vapor-grown fibers in high-volume applications."

General Motors



MARK OF EXCELLENCE

THE MAN BEHIND THE WORK



Dr. Gary G. Tibbetts is a Senior Staff Research Scientist in the Physics Department of the General Motors Research Laboratories.

Gary received his undergraduate degree in physics from the California Institute of Technology. He holds both an M. S. and a Ph. D. in the same discipline from the University of Illinois.

Dr. Tibbetts joined General Motors after two years of postdoctoral work as Guest Scientist at the Technical University of Munich. Since coming to the Labs in 1969, Gary has pursued interests ranging from carbon filaments, to surface physics, to chemical vapor deposition. He has published almost forty papers on the results of his research.

Gary is a member of the American Physical Society, the American Carbon Society, and the Materials Research Society. In 1988, he was a GM Campbell Award Winner. Gary lives in Birmingham, Michigan, with his wife and their three daughters.

The Managerial Challenge in Nuclear Power

SHAPING UP THE NUCLEAR INDUSTRY

High praise and congratulations are due to *Technology Review* for publishing "Making Nuclear Power Work: Lessons from Around the World" by Kent Hansen, Dietmar Winje, Eric Beckjord, Elias P. Gyftopoulos, Michael Golay, and Richard Lester (*TR February/March 1989*). It should be required reading for all persons who deal with nuclear power and aim for an informed opinion on the subject. Moreover, it took courage to give the article such prominence in view of the anti-nuclear atmosphere that prevails in Cambridge, Mass.

MARC A. RIEFFEL
Santa Barbara, Calif.

For those of us who have had a foot in both camps in this country—the naval nuclear program and the civilian power program—there is no disputing the contention of Kent Hansen and his colleagues that U.S. nuclear plants need managerial reform. The naval submarine forces of the world had their big disasters between the world wars, and as a result, no one can rise to the top in modern navies without being trained both as an operator and as a manager. Adm. Rickover built the U.S. Navy's nuclear fleet on these traditions and found he needed to further increase the level of training by setting up a special exam for engineer officers and a special course for commanding officers. In the U.S. electric utility industry, by contrast, knowledge of operations has never been a way into corporate management. And any such knowledge comes only from hand-me-down on-the-job experience, not from formal training.

HOWARD SHAFFER
Northborough, Mass.

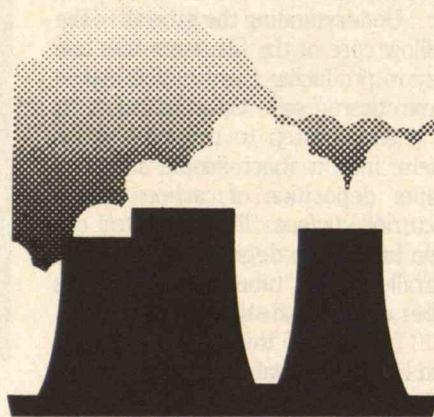
"Making Nuclear Power Work" is one of the most balanced, informative, and objective reviews of the field. However, it should not have limited its scope to light-water reactors of the type used in the United States. Several other kinds of plants are in commercial operation throughout the world, and there is even a high-temperature gas-cooled reactor operating commercially in this country.

As the authors indicate, light-water reactors have to be shut down for refueling 12 percent of the time. It is not clear to me whether the charts of operational availability featured in the article take that into account. If they don't, they are masking a "true" availability of about 50 to 60 percent. Some of the plants not mentioned have no

such drawbacks—for example, Canada's Candu heavy-water reactor, which is refueled continuously while in service.

In addition, the core of the Candu is accessible at all times. In principle, the plant can be completely emptied of fuel in many types of accidents, greatly increasing the potential safety of the system. The downside is that this type of reactor is ideal for producing weapons-grade nuclear materials, which has limited its markets in a politically unstable world. But safeguards are possible, and with them in place the Candu reactor is perhaps the best design in commercial use today.

PETER S. HIGGINS
Glendale, Calif.



"Making Nuclear Power Work" uses data only through 1984. Yet Lando Zech, chairman of the Nuclear Regulatory Commission, has recently stated that since 1984 "there has been a clear and definite improvement" in the "key nuclear parameters used to monitor reactor operation safety." In particular, he points to decreases in significant operating events, unplanned automatic shutdowns, safety-system actuations, radiation exposure to personnel, and precursor events per operating reactor. The nuclear industry has also seen "improvements in plant reliability and availability," he adds, citing data that show "an increase in the average capacity factors for U.S. reactors from about 59 percent in 1986 to almost 67 percent through the first three quarters of 1988."

We now have the data for all of 1988. They show that the increase in capacity factor is the equivalent of bringing another five nuclear power plants on line. Furthermore, the marked improvement in performance was achieved even though seven nuclear units were shut down during most of 1987 and

1988. If those seven units are not counted, the average capacity factor for U.S. nuclear plants during 1988 would be 70 percent—roughly the same as that for many of the countries in the authors' study.

It is unfortunate that by publishing an article based on an out-of-date report *Technology Review* has misled the scientific community and the public.

HAROLD B. FINGER
Washington, D.C.

Kent Hansen responds:

We had at least two reasons for limiting our study to one type of reactor. First, since we wanted to identify cross-national differences in performance, examining cross-technology differences as well would have increased the complexity of the study enormously. Second, we lacked the resources for such a complex study. Also, the data presented in our report includes refueling losses under scheduled outages, so there is no "masking."

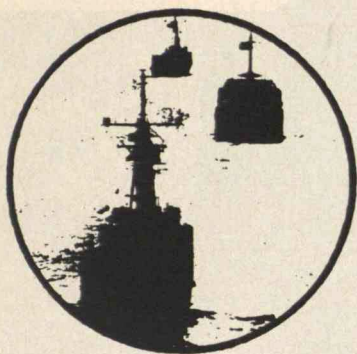
Mr. Finger is correct in pointing out that our data are not recent. When we began our study in 1985, the only data available were for 1984 and earlier. By the time we finished the analyses, data for 1985 were available, and a review showed no major changes in U.S. performance. However, the time between completing the study and publishing the article was long, partly because of more studies to compare safety regulations. Another problem was the inefficiency in reaching consensus among six authors.

In spite of the delay, there still are useful lessons to be learned from international differences. We would be interested in analyzing the recent improvements in U.S. performance to evaluate our recommendations to the nuclear industry.

ARMS AT SEA

William M. Arkin's article "Troubled Waters: The Navy's Aggressive War Strategy" (*TR January 1989*) does more to cloud those waters than clarify them. We are concerned that what he offers as a critique of the Maritime Strategy, the Navy's plan to prepare for a lengthy conventional war with the Soviets, actually masks another agenda.

First, Arkin is apparently opposed to the use of any kind of force. More serious observers recognize that force may sometimes be necessary—particularly when confronted by parties who will not respond to diplomatic or economic measures. For instance, what happens if we do not provide escorts for oil tankers through the Persian Gulf mine fields? What happens if we do not respond



to Libya's support for terrorism?

Arkin also seems to think the mere issue of military resources is always provocative, although such shows of strength have long signaled that a nation simply intends to deter those who would threaten its interests. Since 1945 the United States has employed a "forward defense" strategy, but given the public abhorrence (post-Vietnam) to placing ground troops on foreign territories, we have been largely restricted to naval forces outside of NATO.

Even if we decide that these tactics are not appropriate anymore, we must consider the issue in the context of formal commitments, national interests, and the consequences of withdrawal. Some argue that guaranteed rapid escalation to nuclear war is a good way to deter conventional conflicts (a strategy known as "tripwire"). In this case we should have weak conventional and strong nuclear forces. Others argue that deterrence is best achieved by demonstrating a capability to fight and win at nearly any level (a strategy known as "flexible response"). In this case we should have strong conventional forces and can probably accept nuclear parity. Unfortunately, the tripwire approach, although quite inexpensive, lacks credibility, and the flexible response approach, although credible, stretches national resources. The middle ground, represented by the Maritime Strategy, is to create a limited ability to fight conventionally but admit that nuclear capabilities are a fact of life.

Arkin argues against all these ideas but provides no substitute, except for a vague "negotiated peace." He conveniently forgets that arms-control efforts have often failed—most importantly in areas of verification and compliance. Moreover, diplomatic agreements tend to lag behind technological developments. We do not mean to say that negotiated solutions cannot be achieved, or that arms control is impossible for naval weapons. However, Arkin should at least say

why he thinks his proposals are feasible, and advantageous.

He should bear in mind that the United States has tried, fairly successfully, to maintain naval superiority over the Soviets while ceding an advantage in ground-force capability. This is a reasonable arrangement, since the United States is essentially a maritime, trading nation, while the Soviets are a classic continental power. Soviet sensibilities should be far less threatened by naval forces than by ground forces. Indeed, the Soviets have recently agreed that naval resources would be excluded from discussions of conventional forces in NATO. Yet Arkin believes we should abandon naval supremacy and ask nothing in return.

Actually, it is quite possible that his proposals hinder rather than enhance peace and security. Without nuclear weapons at sea, we could not use anything other than intercontinental weapons to hold targets in the Soviet Union at risk—that is, unless he wishes to void the INF Treaty.

Some of his other suggestions, such as notifying fellow nations of naval exercises, indicate rather strange interpretations of international law. Why would any nation ask permission to engage in lawful conduct? In addition, agreeing to refrain from what he calls dangerous maneuvers and harassment at sea is, of course, the subject of ongoing bilateral discussions.

Finally, Arkin misuses statements by Admiral Watkins (former Chief of Naval Operations). When Watkins commented that "the Navy runs eyeball to eyeball with the Soviets daily" and that "our operating tempo is about 20 percent higher than in the Vietnam war," his intent was to ask Congress for some relief. Naval personnel were spending up to 10 consecutive months at sea, away from their families, and the ship hulls were being worn out. Even though Arkin is surely aware of the purpose of Watkins's testimony, he introduces these quotes as evidence that "the United States and its major allies keep their navies at a wartime cadence."

There are valid critiques of the Maritime Strategy. It may not be affordable, and some aspects may be unworkable or politically unwise. But Arkin's piece does nothing to further legitimate debate on these points.

STEPHEN O. FOUGHT
JACK B. RECTOR
Newport, R.I.

Stephen O. Fought is a professor at the U.S. Naval War College, and Jack B. Rector, Commander, U.S. Navy, is a student there.
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TRENDS



Jeremy Harris (left) and James DeLaurier have designed an ornithopter that could imitate bird flight.

Like a Bird

God, wind tunnel, carbon composites, and computer simulations willing, scientists could realize one of the oldest dreams of flight this summer. From a hill in Toronto, the world's first successful "ornithopter" will take off. Combining the Greek words for "bird" and "wing," the 6.5-pound model plane flaps its wings like a bird.

Although toy stores and science centers already sell winged toys driven by rubber bands, these imitate the flight of insects rather than birds. "They are floppers rather than flappers," says University of Toronto aerospace engineer James DeLaurier, one

of the ornithopter designers. A bird's wings generate lift and let it glide. As for the toys, they simply push the air down. "If the power stops, they will drop out of the sky."

The result of a 15-year fascination with flight by DeLaurier and his colleague Jeremy Harris, a research engineer with the Batelle Institute in Columbus, Ohio, the ornithopter could culminate a several-thousand-year effort by humans to fly like birds. "Aerodynamically, this is one of the most difficult problems I have ever faced," says DeLaurier about the challenges on which they have spent \$6,000 of their own money.

The engineers believe they have overcome two kinds of difficulties. One is that a wing's up-and-down movement is quite violent. This

caused structural failures in their earlier efforts, but the current ornithopter may hold together, since it incorporates light modern materials from the U.S. space program—carbon composites and Kevlar. The main spar on the wing is made of graphite, which provides two to three times the strength of aluminum.

The other problem, which sabotaged a more famous attempt to build an ornithopter, is getting enough power without adding too much weight. In the mid-1980s, Aero-Vironment, Inc., of Monrovia, Calif., tried to construct an artificial pterodactyl, modeled on a flying dinosaur with an 18-foot wingspan. However, the company's analysis, confirmed by the Toronto group's computers, indicated that the project would never be able to bal-

ance weight and power requirements.

The U.S.-Canadian team believes it can overcome the weight problem with a patented lightweight drive mechanism and a new shape for the part of the wing that provides lift. The Toronto ornithopter uses an ordinary model-plane engine, and a series of pulleys and belts hooked to the motor makes the wings move up and down. To further cut down on weight, the plane has no landing gear, so it must be launched from a hill and crash lands.

The ornithopter wing has ended up imitating the shape of a bird's wing, although the engineers did not set out to do this. But their computer analysis has indicated that the design of a gull's wing is the most efficient one for flap-wing flight.

A view from Washington



NO MORE WISHFUL THINKING

By Harold B. Finger
President and Chief Executive Officer
U.S. Council for Energy Awareness

For too long, wishful thinking has dominated energy policy. The wishful thinkers tell us we don't need to build more power plants. They tell us we don't need to drill for oil and natural gas in frontier areas. They always have easy ways to avoid the problem.

They're dangerously wrong. We have an energy crisis coming. First, we're increasing our dependence on foreign oil and, in the process, gambling with our energy independence and our national security. Second, electricity demand is growing faster than new supplies are being added because of our continued economic growth. In some parts of the country, electric reliability is already threatened.

It's time to face up to our energy needs realistically. We cannot depend on "what if..." scenarios that won't deliver results for years, if at all.

Let's drop the wishful thinking and look at the facts instead.

In the last 15 years, since the 1973 oil embargo, the U.S. has made great strides in conserving energy and improving efficiency of energy use. Since 1973, our Gross National Product has grown 46 percent, but our *total* energy consumption has risen only 8 percent. That's great progress.

But those numbers don't tell the whole story. During that same period, demand for electricity has grown about 50 percent—roughly parallel with GNP growth. Clearly, electricity has fueled much of the growth in the U.S. economy over the past 15 years. And we must have additional, reliable, affordable supplies of electricity if our economy is to continue to grow.

For many reasons, most of them beyond the electric industry's control, plans for adding new generating capacity are not keeping up with increasing demand. Construction of new power plants is at a 15-year low. New capacity planned over the next 10 years will support growth in electric sales of only one percent per year. That's one-fourth the rate of growth we've experienced over the last six years.

The Oil Problem

Building new power plants is only part of the solution. We must also ask ourselves: what kind of power plants? The U.S. is already dangerously dependent on foreign oil and that dependence is rising. Imports represent nearly 50 percent of U.S. oil consumption. Last year, payments for foreign oil accounted for about one-third of our trade deficit and that bill is increasing.

What does this have to do with electricity? Today, over 25 percent of U.S. electric capacity is still fueled by oil and natural gas. Because oil-fired electricity is costly, electric utilities try to reserve that capacity for times of very high demand. If we don't meet rising electric demand with domestic fuels—like nuclear energy and coal—utilities will be forced to use those oil-fired plants more of the time, worsening our foreign oil dependence and boosting our electricity costs.

Unfortunately, we're already moving in that direction. Back in 1973, electric utilities used about 1.5 million barrels of oil per day. By 1987, thanks largely to new coal and nuclear electric power plants, utilities had cut that to about 500,000 barrels per day. But in 1988, utility oil use increased—to 675,000 barrels per day, a 24 percent increase. And by the mid-1990s, utilities will be burning about 1.8 million barrels per day—almost all of it imported. That's worse than 1973. Our nation is so dependent on foreign oil for other uses, like transportation, that we simply cannot afford to make the situation worse by using foreign oil to generate electricity.

The Nuclear Energy Solution

We can head off looming problems, and nuclear energy should be an important part of our energy strategy.

Nuclear energy has not always been a financial blessing for electric utilities, because of punitive treatment by state regulators who have refused to let companies recover the cost of building the plants. But nuclear energy has been an unmixed blessing for the U.S. and its people.

Nuclear energy is our second largest source of electricity, after coal. U.S. nuclear plants have cut consumer electricity costs by over \$50 billion since the 1973 oil embargo. The spent fuel from all our commercial nuclear plants has been managed scrupulously at carefully controlled sites. And our plants have operated safely. We learned much from the Three Mile Island accident. The jolt it gave the industry's confidence led to substantial improvements in operation and design. The trends in plant performance tracked by the Nuclear Regulatory Commission and the Institute of Nuclear Power Operations prove this. They show steady improvement in all areas of nuclear plant performance.

Finally, our nuclear plants have reduced oil imports. Since 1973, nuclear energy has displaced nearly 4 billion barrels of oil and cut our foreign oil payments by over \$114 billion.

With such a record, there's no question that nuclear energy should play a larger role in supplying our future electricity needs.

These are facts. Wishful thinking cannot deliver so well.



Harold B. Finger

Why build a plane that flies like a bird? While DeLaurier can think of possible applications, such as aircraft that can take off and land in a short space, flapping flight is unlikely to replace conventional aircraft. On the other hand, the research has begun to yield insight into a biological problem: how the earliest birds flew.

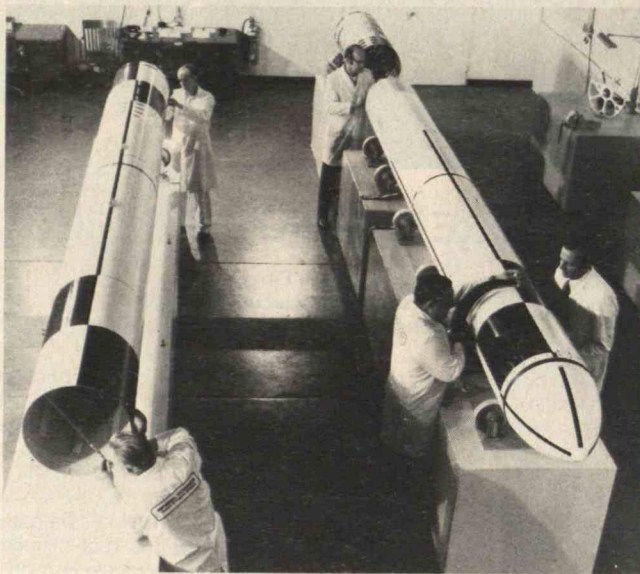
Drawing on the ornithopter research, Susan Haigh, one of DeLaurier's graduate students, has begun to answer the question of whether the archaeopteryx could fly. Fossils show that this 165-million-year-old creature had feathers and a bird-like body, but paleontologists don't know if it took off from and landed on the ground or climbed trees and rocks to launch itself in a kind of hang glide.

Haigh is combining the Toronto laboratory's aerodynamic models with Norwegian zoologist Ulla Norberg's analysis of the wingspan of the archaeopteryx. She is combining this with weight evidence from fossil records. Her findings have convinced Haigh that the archaeopteryx were true flyers.

In another project, DeLaurier is working with Bruce Fenton, a biologist at Toronto's York University who has a special interest in bats. The flapping-wing dynamics of bat flight pose a special problem. Unlike egg-laying birds, the winged mammals must fly while weighed down during pregnancy.

"Our work is a classical example of how a seemingly frivolous research project can spin off science," says DeLaurier. ■

STEPHEN STRAUSS is a science reporter for the Toronto Globe and Mail.



Since no one has perfected a way to monitor compliance with limits on sea-launched cruise missiles, they are a daunting obstacle to arms control.

search at Livermore, it could be a sophisticated electronic device that a superpower could monitor by radio. Woodruff notes that tags could also aid in verifying limits on other mobile missiles or even conventional weapons such as tanks.

Weapons Scientists Retool

As East and West grope toward more comprehensive limits on their weapons, some designers of nuclear arms are finding a niche in helping shrink the U.S. arsenal. Lawrence Livermore National Laboratory and other Department of Energy (DOE) facilities have expanded their efforts in arms control, adding new programs and dramatically expanding older ones.

In the past, the superpowers monitored treaty compliance through spy satellites, earthquake sensors, and similar means. But as agreements have grown more detailed, verification requires more sophisticated techniques, creating a demand for the weapons labs' expertise, multi-billion-dollar facilities, and reputation for independent thinking. Despite federal fiscal woes, DOE's budget for researching ways to monitor compliance grew 20 percent this year.

At Livermore, "the lab's particular role is in technical issues," says former director Michael May, a respected arms-control expert. "That's our stock-in-trade." Researchers are looking at meth-

ods to count mobile Soviet missiles, confirm the reliability of stockpiled weapons, and model the impacts of potential treaties.

Among the most daunting challenges are verifying limits on sea-launched cruise missiles (SLCMs). These weapons are small and easy to hide, and nuclear and non-nuclear SLCMs look exactly alike. Without a reliable verification system, negotiators and Congress would hesitate to approve a treaty.

Livermore researchers are investigating ways to tag SLCMs, so each side could count the number of markers. Soviet officials would tag U.S. weapons as they left the factory, and U.S. officials would do the same in the Soviet Union. "It would be somewhat like an inspector stamping 'USDA prime choice' on a piece of beef," Woodruff says. But the system must be foolproof. "You don't want the Soviets to be able to take [a tag] off the missile and put it on something else."

A tag could be as simple as a serial number, big enough to be seen from a satellite, painted on the missile's side. Or, says Roy D. Woodruff, head of treaty-verification re-

A Question of Objectivity

Livermore researchers believe their conclusions are particularly valuable because they provide a degree of objectivity that is often absent from arms-control debates. Paul Brown, head of Livermore's arms-control office, says the University of California operates the facility and lab workers are university employees. Thus the staff is protected from some political pressure and can provide technically accurate opinions.

Indeed, at times Livermore has stepped on federal toes. In 1987, it publicly disputed the Reagan administration claim that the Soviet Union had exceeded limits on the size of nuclear tests. Brown also cites a recent Livermore study sharply critical of plans to base MX missiles on trains. The report argues that trains, garrisoned in military bases during peacetime, would be vulnerable to surprise attack. This could encourage rapid escalation during a crisis.

On the other hand, skeptics of Livermore point out that the MX is an Air Force program, not a lab project. "I don't think that was any bold statement, and it doesn't crimp the lab one bit," says University of Maryland political scientist Steven Fetter,

who was a postdoctoral intern at Livermore in 1985.

Fetter and others suggest that the lab is less intellectually honest about arms control when the issue strikes closer to home, as in the case of underground testing. Many arms-control advocates favor stricter limits on underground nuclear tests, or even outright prohibition. However, the lab, which receives funding to conduct the tests, officially opposes sharper constraints, maintaining they would imperil national security. The lab's position is that some nuclear weapons must be exploded occasionally to ensure that stockpiles will work when needed.

On this point, there is dissension within the lab. Livermore physicist Ray Kidder has concluded that thoroughly tested weapons don't need further trials. He charges that Brown and other Livermore officials have blown flaws in past weapons out of proportion. "That way, they could come out with the answer they wanted," Kidder says.

Nevertheless, the lab recently began underground nuclear tests aimed at developing ways to check a weapon's performance with smaller blasts. And Troy Wade, DOE assistant secretary for defense programs and a former Livermore employee, says the lab is credible to him: "Since they are responsible for the U.S. nuclear-weapons design program, they certainly are uniquely qualified to assess the nuclear programs of our adversaries." He adds that such assessments are "a big input to any negotiation." ■

Appropriate Biotech

B iotechnology promises an era of designer pharmaceuticals, high-yield agriculture, and low-cost manufactured food. But researchers in a number of disciplines warn that biotechnology could yield few benefits, and some real damage, in the Third World.

Currently, biotech research is concentrated in the United States, Europe, and Japan. As a result, most of the work pursues the concerns of these countries and the firms that provide most of the funding.

For instance, biologists

could develop potatoes that resist insects or yams that would grow in unfavorable climates, yet little biotech research is being applied to these foods, explains Cornell University rural sociologist Frederick Buttel. "They are not of interest to private firms, mainly because the people in the Third World who grow them do so for domestic consumption."

Similarly, large biotechnology companies are developing pharmaceuticals such as the heart drug tPA for affluent markets. But according to Buttel, these firms are less interested in developing drugs to treat malaria—a disease suffered largely by poor people in poor countries.

Rodolfo Quintero, general director of the Regional Pro-

gram of Biotechnology for Latin America and the Caribbean, worries that market-driven technology might eventually even harm the economies of developing nations. Quintero, whose Mexico City lab is funded by two United Nations agencies, believes that bioengineered products could displace some Third World exports. He cites coffee, cacao, and vanilla as examples. "You can now produce chili—the hot flavor"—in a laboratory, he points out. "So if the price is right, you don't have to buy chili from Mexico."

Little biotech research is conducted on crops like cacao that are important to Third World farmers.



VINCENT KIERNAN was a Knight Journalism Fellow at MIT.

At the same time, biotechnology could encourage technology-intensive agriculture in Latin America. According to Quintero, this would benefit richer farmers, who profit from exports such as flowers and fruit, to the detriment of smaller farmers growing corn and other crops for use in their own countries.

Martha Gilliland, director of the University of Nebraska's Center for Infrastructural Research, agrees. She recently studied the impact of nitrogen-fixing biotechnologies on corn production in Mexico. "So much of what is being developed in biotechnology is directed toward large-scale corporate farming," says Gilliland. "That is likely to exacerbate the bifurcation that already exists in Mexico between the upper class and the peasants."

A Fair Exchange

A few projects in developing nations support biotech research that tackles Third World problems. Quintero's lab has chosen "particular projects that we think will benefit the region." For example, one experiment is geared to producing different varieties of penicillin, a drug now manufactured only in industrialized countries. Other projects focus on improving agricultural crops like corn, sugar cane, and potatoes.

A few developing nations, notably Brazil, Cuba, India, and the Philippines, boast similar biotech research facilities—some larger than the U.N. operation in Mexico City. Nearly all are publicly funded, but, Quintero says, they still lack the resources of large corporations. Quintero himself operates on a budget of less than \$1 million. "With our resources, you can do the research, but you cannot go

to pilot plant."

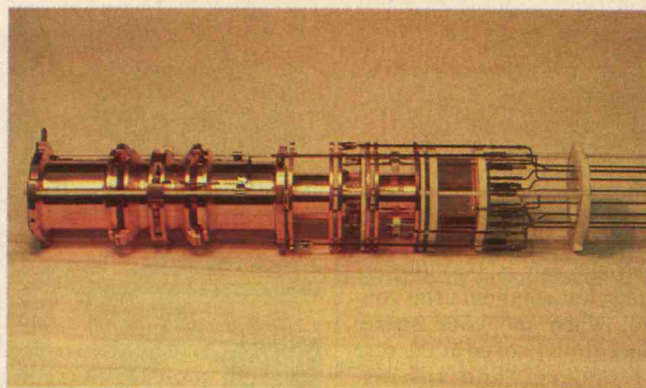
Moreover, building research infrastructures for biotechnology in Latin America, Africa, and Asia could be expensive and problematic, says Roger Beachy, director of the Center for Plant Science and Technology at the University of Washington. For example, most developing countries lack sufficient trained personnel and the continuing financial resources to purchase expensive biochemicals. Other obstacles include poor communications and haphazard supplies of water and electricity.

Nevertheless, U.S. firms are paying some attention to Third World needs. With Monsanto scientists, Beachy and his colleagues have developed a process to create virus-resistant plants, including cassava, which is a Third World tuber. To overcome the lack of facilities in Africa, the researchers brought plant cells to St. Louis and did all the work in facilities at the University of Washington and Monsanto.

But, notes Beachy, even if the research succeeds, it doesn't answer a key question about marketing products in the cash-poor Third World: "What does a Ciba-Geigy or a Monsanto do if they spend \$10 million on developing a gene? Do they want to give it away?"

One answer is that an exchange might be possible, since developing nations are a storehouse for much of the world's genetic diversity. "There's a total lack of appreciation in the First World of what that resource is worth," says Martha Gilliland. ■

THOMAS KIELY, a frequent contributor to Trends, specializes in business and medical issues.



Atomic Timekeeping

This electromagnetic trap holds the beryllium ions that calibrate atomic clocks. Such timepieces err by only 1 second in 3 million years.

Clock watching is a sign of boredom at most workplaces. At the National Institute for Standards and Technology (NIST), it means involvement. NIST scientists in Boulder, Colo., and Gaithersburg, Md., constantly tinker with the atomic clocks that serve as the ultimate synchronization tool. Now lasers are helping the agency develop its most accurate timepiece yet.

Atomic clocks measure time indirectly. When a beam of electromagnetic radiation oscillates at exactly the right frequency, it can produce a detectable shift in an atom's internal energy. That frequency—the number of oscillations per second—can be used to calibrate a clock, and the goal of atomic timekeepers is to find the precise frequency needed to stimulate a particular atomic change. The process is much like tuning a radio until a particular station comes in clearly.

First tested in January, the latest atomic clock will err by less than a second in 3 million years. That marks a 10-fold improvement over the 1978 standard and gives NIST the world's most accurate clock. The new clock was also a fitting milestone to mark atomic timekeeping's fortieth anniversary: the world's first

atomic clock debuted in January 1949 at NIST's predecessor, the National Bureau of Standards.

Even more precision is on the way. By 2010, NIST scientists believe, accuracies may approach one second in 10 billion years—the approximate age of the universe. According to NIST physicist Don Sullivan, this superclock will require no breakthroughs in understanding. Researchers need only refine existing theories and hone existing techniques. "We think we understand all the sources of error that come into play."

"Certainly these accuracies may sound ridiculous," says Dave Wineland, another NIST physicist, "but if satellites had more accurate atomic clocks, [navigators] would use them." Satellite networks equipped with atomic time now guide ships and planes to within several feet of a desired location. "The main driver in this whole business of accurate clocks is navigation," he notes.

Information transfer should also benefit, Wineland believes. "As the bit rates [of data processing] go higher and higher, timing becomes more important." The performance of modern computer workstations is measured in millions of instructions per

second, so a computer's ability to shuffle incoming data efficiently depends on the precision of its internal clock.

Atom, Be Still!

Traditional techniques in atomic timekeeping measure frequency changes by vaporizing an element and sending the atoms through an obstacle course of magnets that separate "shifted" and "unshifted" atoms. But that procedure introduces Doppler errors—that is, changes in frequency caused by relative motion. Just as the Doppler effect makes ambulance sirens seem to change in pitch as they pass by, it makes atomic clocks less accurate when the reference atoms are moving.

The solution is to observe atoms at rest. NIST has found that single atoms, if ionized, can be held in tiny electromagnetic traps. That way, micro-scale photography can verify the tiny but visible amounts of fluorescent light that signal energy changes.

But even a trapped atom isn't completely still. Some Doppler error remains because of temperature-related vibrations. These can be lessened by drastically cooling the ion, which is where lasers help. A set of converging laser beams pressures the ion into almost total stillness. The resulting temperature typically falls within one ten-thousandth of a degree Kelvin of absolute zero.

This wasn't practical until the frequency of the laser

beam could be made pure enough, according to Wineland, who pioneered laser cooling in 1978 with NIST's Robert Drullinger and Fred Walls. Lasers in medicine and elsewhere don't have to be nearly as precise as those in atomic clocks. Only this year has NIST surpassed its standard atomic clock with a laser-cooled variety.

Choosing a good reference atom for the laser-cooled clock was also vital. Measurement precision is directly tied to the frequency needed for atomic changes: the higher the frequency at which an atom shifts, the higher the potential precision. Cesium has been the worldwide atom of choice for 35 years, says Wineland, since its properties are easy to work with in the

rarefied clock environment. "You can make a vapor out of it at a moderate temperature, and it's not particularly corrosive."

For the laser-cooled prototype, NIST switched to beryllium, which is especially responsive to lasers. Mercury seems the most promising element for future clocks, with an atomic-change frequency in the ultraviolet range. However, mercury is far less amenable to laser cooling.

Thus, the slow, systematic search for a better candidate continues. Says Wineland, "We just repeatedly look through all the elements in the periodic table." ■

ROBERT HENSON is a freelance writer specializing in the physical sciences.

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Seawater to Drink

As drought continues to threaten many regions, seawater is becoming a reasonable solution to the dearth of potable water. Once an exotic process limited to desert settlements and expensive island developments, desalination now appeals even to large cities.

Pouring out 2 billion gallons a day worldwide, desalination plants currently

supply the needs of high technology, oil refineries, and power plants. They also quench the thirst of entire communities. In Florida, which leads the United States in residential use, the largest of 110 desalination plants serves the city of Cape Coral, delivering 15 million gallons a day.

One reason for desalination's increasing popularity is the steady decline in the

amount of fuel it requires, which is the main cost of the process. Modern techniques generate 100 units of water for every unit of energy consumed. Four decades ago, rudimentary distillation took 25 energy units to produce a unit of drinking water.

All the major desalination methods are variations on the same basic technology that first saw widespread duty on pre-World War II ships: boiling salty water—with heat from the engines in the case of ships—to release purified vapor. After World War II, distillation technology moved to land, especially in the Middle East. In 1965, Israel built its first seawater distillation plant for the new desert town of Eilat. When Arab countries grew wealthy from oil, they followed suit on a grand scale, providing water for their desert communities.

Most Middle East plants use flash distillation. When seawater enters a vacuum chamber, it instantly boils or "flashes" into salt-free vapor. Linking a series of chambers raises the efficiency of the process, but it still requires a lot of fuel.

Countries that are influenced by rising energy prices have adopted more cost-effective technologies, such as multi-effect plants. In these, seawater circulates through tubing heated with steam from preceding chambers. This increases a plant's efficiency because each chamber's heat helps fuel the next.

In the 1970s, an Israeli firm reversed that design, so the tubes carried steam instead of brine. According to Natan

Berkman, former director of Israel Desalination Engineering, incoming brine is continually sprayed onto the hot tubes, where it evaporates. This makes removing salt deposits relatively easy, since they are left on the outside, rather than the inside, of the tubes. Spain's Canary Islands now bristle with tourism, Berkman says, thanks to these modified multi-effect plants.

Technology of Choice

In Florida, as in most of the world, reverse osmosis has become the technology of choice, because it makes desalination "cost-competitive with other new sources of water," says Phil Overeynder, water-development engineer for Santa Barbara City, Calif. In this process, high pressure pushes water through semipermeable membranes, leaving salts behind.

For a decade or more, reverse osmosis has supplied the pure water that silicon-chip manufacturers require. Other regions are now picking up the technique for general use. For example, a reverse-osmosis plant has been proposed to ease the plight of Santa Barbara County, whose water expenses have climbed steeply since the 1970s, when it decided not to join the California Water Project.

With a capacity of 500 to 2,000 acre-feet a year, the new plant would supply 10 percent of the county's current water needs. It would cost \$1,800 to \$2,500 per acre-foot. "A lot of places choke at paying \$200 an acre-foot," says Overeynder. But he adds that the costs for some other water projects in southern California already approach \$1,000. If Santa Barbara goes ahead with its



The temperature difference between the ocean's surface and its depths helps Keahole, Hawaii, purify 8,500 gallons of water daily.

plant, Overeynder says, "it would be the first of its kind in the country" to desalt so much seawater.

But although such systems go a long way toward making desalination affordable, Weizmann Institute scientists in Israel are trying to reduce costs even further. Their goal is to harness electricity from the contrasting salt concentrations where rivers meet oceans. This "osmotic differential" generates an electric current that could power desalination plants at the mouths of large estuaries, cutting fuel expenses.

Another approach, ocean thermal energy conversion (OTEC), would take advantage of temperature gradients in deep tropical oceans. Engineers at Argonne National Labs and the Solar Energy Research Institute in Golden, Colo., are pursuing this idea.

OTEC injects warm water from the ocean's surface into low-pressure chambers, where the brine vaporizes through flash distillation. Cold seawater drawn from deep currents condenses the steam into salt-free water. But before that, the steam drives turbines, generating the electricity to depressurize the flash chambers.

A pilot OTEC plant at Keahole Point in Hawaii is purifying 8,500 gallons a day. However, the Gulf Coast and southern California might be the only regions off the U.S. mainland with great enough water-temperature differences for OTEC to work. The Middle East would also fit the bill, but with no need to conserve oil, nations there have been slow to show interest. ■

ROBERTA FRIEDMAN is a free-lance science reporter in Santa Cruz, Calif.

Super Weeds

Corn that repels insects, tomatoes that stay firm on the vine—the age of the super vegetable is coming. But as the commercial use of genetically engineered seeds approaches, some researchers warn that altered plants could upset the agricultural ecosystem.

Would crops designed to resist droughts, disease, insects, or herbicides pass those traits to weedy relatives nearby? The result could be super weeds. Recent findings both support this concern and provide some reassurance.

Scientists first successfully altered the genes of plants in 1983, and about two dozen test crops are now growing in U.S. fields. The U.S. Department of Agriculture (USDA) and the Environmental Protection Agency approve field tests on a case-by-case basis, using regulations issued several years ago. Early applications were for tobacco, tomatoes, and some varieties of corn, but applications for 1989 are much more extensive, including tests on altered potatoes and soybeans.

Two causes for worry are findings by a number of researchers that wind blows pollen much farther than anyone had thought, and that a considerable portion of the new seeds bear new genetic material. These scientists have used techniques that look directly at the structure of genes.

Such gene analysis provides "a tool to look at the issue of risk in more detail than ever before," according to Ralph Hardy, a member of the Na-

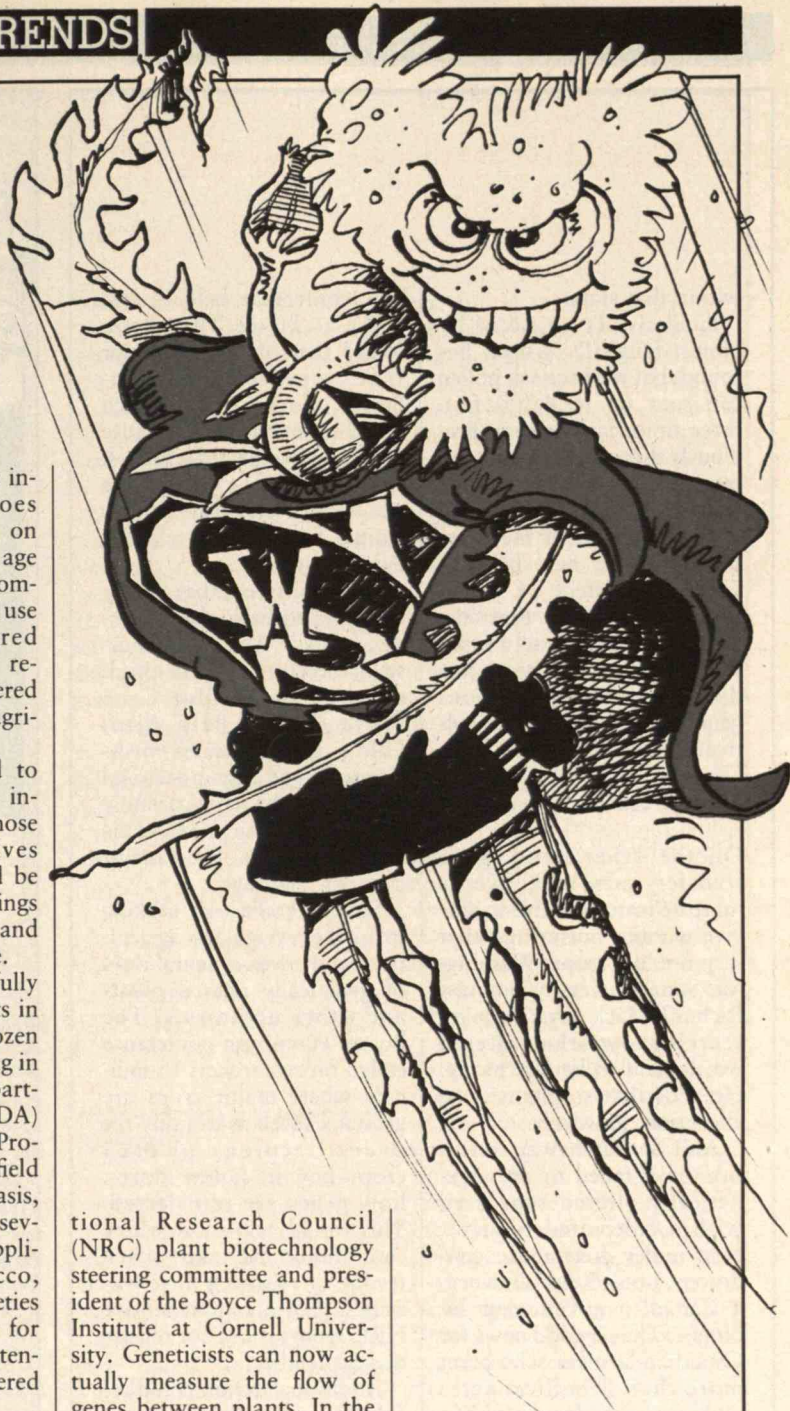
tional Research Council (NRC) plant biotechnology steering committee and president of the Boyce Thompson Institute at Cornell University. Geneticists can now actually measure the flow of genes between plants. In the past, they inferred it from the number of hybrids produced.

Last year, Norman Ellstrand, an ecological geneticist at the University of California at Riverside, showed that up to one-fifth of the genes of wild radishes could be exchanged between fields as much as 3,000 feet apart. This refutes the long-held belief that pollen from wild radishes couldn't move more than 300 feet.

Ellstrand concludes that using engineered genes

As biotechnology yields supervegetables, some researchers worry that superweeds could also result.

"could, indeed, be cause for alarm. I never believed there could be that much gene exchange." He points out that several of California's 10 major vegetables—including asparagus, carrots, and celery—have natural weedy relatives



within that state.

Similarly, Texas A&M biologist Hugh D. Wilson has found that wild squash pollen can soar up to 4,300 feet, three times farther than previously thought. According to his gene analysis, a single bee helped carry the pollen, and up to 5 percent of the plant progeny were new hybrids. Given the extent of pollen transfer, he worries that "the prospect of generating a super weed is there, because we just don't know enough about gene exchanges between cultivated and wild plants."

Weak Weeds?

On the other hand, gene transfers may make weeds more delicate, less able to survive without nurturing—that is, more like crops. Washington State University botanist Richard Mack says most research shows that altered weeds tend to be less hardy. He adds that sorghum is an exception, however.

And Saskatchewan scientists have failed to cross genetically altered rape seed with a cultivated relative, even under greenhouse conditions, notes Keith Downey, a Canadian government biologist. That is good news for Canadian farmers, who plant more than 8 million acres with rape seed for its derivative, the oil-producing canola.

University of Georgia ecologist Carol Hoffman cautions that each species must be studied before releasing genetically altered strains. She points out that what is safe with potatoes, which have no wild U.S. relatives, may be dangerous with sorghum, which breeds with Johnson-grass, one of the country's worst weeds. She also cautions against exporting altered seed to countries where wild relatives are common.

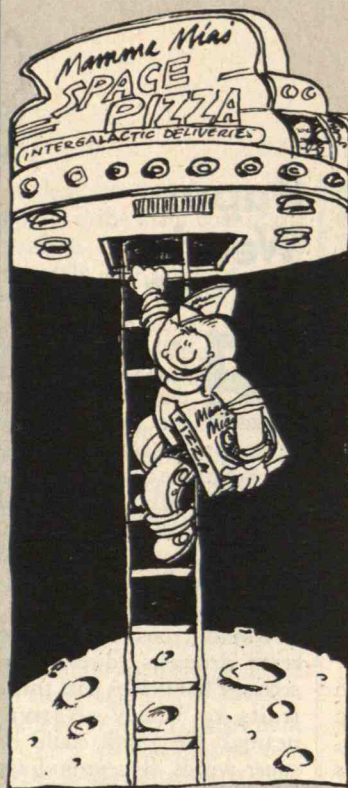
A conference held in late 1987 at Boyce Thompson found that of the 15 major U.S. crops, sorghum, sunflower, clover, and tobacco could be endangered because they breed with wild relatives. And while the 11 others have no weedy cousins in the United States, such relatives exist elsewhere.

Downey agrees that "every crop has to be looked at individually." And Ron Meeusen, director of plant biotech research for Sandoz Crop Protection in Palo Alto, Calif., also advocates investigations of any potential problem. "The more carefully we look at it, the more people will realize it is not a major concern," he says.

Several bodies are seeking to further weigh the agricultural and environmental risks of genetically altered plants and other organisms. The Boyce Thompson conference called on researchers to indicate where major crops are grown, as well as to study the overall ecology of each crop—how its pollen moves, how genes are transferred. This would help show where care should be taken when testing or releasing novel varieties. And a comprehensive NRC report is due for release this September.

Additional action could result from the February announcement that USDA plans to fund gene mapping for important crops. Such maps aid genetic engineering by showing where genes for specific traits occur along the DNA chain. Agriculture Secretary Clayton Yeutter says this data could help U.S. scientists design crops that could compete in the world agricultural market. ■

RENEE TWOMBLY was Knight Science Journalism Fellow at MIT.



22ND CENTURY

"If we can avoid war, avoid dissolving our forests, [and] avoid destroying our water, the dawn of the twenty-first and the twenty-second century will be worth greeting," says Robert Gibson, head of the National Society of Professional Engineers. His organization and eight other groups have asked engineers to predict life a century from now.

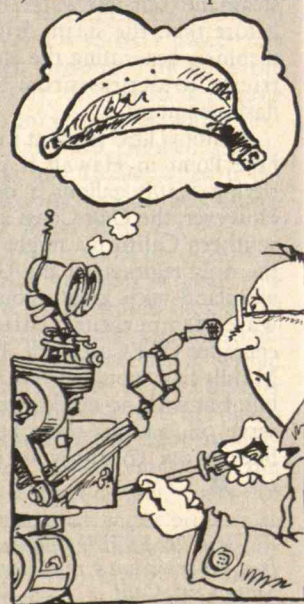
If the predictions are accurate, many of our descendants will live on the moon or artificial planets—but not on Mars. Their activities will include research, manufacturing, and mining—and maybe pizza delivery, suggests one engineer. On Earth, people will inhabit 300-story towers or domed cities, controlled by computers and powered by solar or nuclear energy.

One respondent thinks future transport might be instantaneous, but another doubts such serious changes: "Buck Rogers vehicles are too expensive ... for common modes of transportation."

ROBOT TOUCH

A new electronic "fingertip" could lead to robots that closely mimic the sense of touch. University of Michigan electrical engineer Kensall Wise thinks robots equipped with his "tactile imager" will be able to select specific objects from a bin of assorted parts. "If I reach in my pocket and hold a coin, I can tell it's a quarter by estimating its size and running my fingers across the raised image on the surface," Wise explains. "This device will allow robots to do the same thing."

The accuracy and reliability of other tactile imagers have been too limited for most practical uses, according to Wise. Poor resolution has been a big part of the problem, he says, noting that "the smaller the part, the finer the resolution that is required to 'see' that part." He maintains his microelectronic sensor has the highest resolution yet. Each imaging chip contains 32 tiny strips of metal crossed by 32 rows of silicon strips—all in less than a square inch. The cross-hatching produces 1,024 miniature capacitors.



BETTER TOOLS

Penn State industrial engineer Andris Freivalds wants to design better hand tools for factories and homes. He investigates how to make manual and power tools more efficient, easier to use, and less dangerous.

Currently, Freivalds is studying two-handed garden shears and pruners with grips made of piezoelectric materials. Such materials generate electricity when force is exerted on them, allowing him to map the distribution of hand pressure.

Freivalds would like to design a handle that distributes the pressure evenly. "You might not have to exert as much force to use these tools," he notes, which might also "eliminate the calluses and blisters frequently suffered by weekend gardeners."

UNION COMPUTER

Jeffrey Pector has written what he calls "the first computer program designed to help unions level the playing field with corporate America." According to *PC/Computing* magazine, Grassroots PLAN—Political and Legislative Action Network—offers "mass-membership organizations a tool for organizing their most precious resource—people."

The program lets a group produce a customized database that classifies members according to their interests and demographics. Grassroots PLAN can then generate letters to members who have specific concerns. "Legislators are becoming more and more responsive to constituent pressures," says Pector. "This program is designed to encourage organizations to adapt to that trend by helping them mobilize members."



SALSA SNIFFLES

Nosing around with nasal nuisances, scientists at the National Institute of Allergy and Infectious Diseases have identified the biological events that trigger the "salsa sniffles." Eating spicy foods sets off these rarely serious but often annoying attacks. But drugs can stifle the condition, so diners may one day snort nose drops and enjoy their hot meal.

"I got interested in this because it happens to me," says allergy researcher Gordon Raphael. "When I eat hot-and-sour soup at a Chinese restaurant, my nose drips like a faucet. It's a common nuisance syndrome that nobody's looked into."

According to Raphael and his colleagues, a food-induced runny nose—"gustatory rhinitis"—results when certain ingredients in spicy foods stimulate chemical receptors in the mouth. This launches a response in the nervous system, setting off the profuse nasal dripping.

WATER SOURCE

A marshmallow-sized electronic gypsum block could save farmers millions of gallons of water. The environmental research group INFORM has announced

successful tests of the device, which could detect over-watering and other irrigation problems.

Gypsum blocks lose and absorb moisture much like soil does, and when buried in a field, they can monitor changes in moisture. Each of the blocks INFORM has developed contains two electrodes, with wires extending to an electric meter on the surface. More current passes through the circuit when the soil and the block are wet.

Readings once or twice a week would show farmers when to correct their irrigation practices. The method costs only a few dollars per acre, yet a three-year study found that it reduced water use up 58 percent. The benefits in a single season included cutting water costs up to \$90 per acre and raising crop yields as much as \$125 per acre.

COLUMBUS LANDED WHERE?

As the five-hundredth anniversary of Columbus's voyage approaches, researchers are still uncertain how he spent his first two weeks in the Bahamas, where many islands claim a "Washington slept here" honor. Steven Mitchell, a geologist at California State University-Bakersfield, is filling in the gaps by "reconstructing" the coastal environments of Concepcion, Crooked, Long, and San Salvador islands and Rum and Samana cays. He plans to compare the reconstructed features with those described in Columbus's log.

It requires a detective to see the geography of the fifteenth century in the contemporary islands. The landscape has changed significantly since 1492: shorelines have shifted, ponds have dried, and vege-

tation has disappeared. Moreover, although Columbus recorded nearly 1,000 observations in his journals during his travels through the Bahamas, only indirect records of his sojourn survive.

WOOD CARS

Roger Rowell dreams of wooden cars. A chemist at the University of Wisconsin-Madison, he uses acetylation, a well-established and simple process, to overcome many of wood's drawbacks.

He dips wood particles, flakes, and fibers—and even grass clippings—into acetic anhydride for 10 seconds and then heats them at 250°F for several hours. That way they absorb little water and resist rot and insect damage. Formed into composites, they are strong, smooth, and resist changing shape.

Rowell has blended acetylated fibers with polyester to make pads that are 90 percent wood. These can be pressed and molded into circuit boards, furniture, or containers. Automobile manufacturers could coat wood-polyester mats with veneer to make dashboards, interior moldings, and trim. Or, says Rowell, a fiberglass-covered acetylated wood could yield car bodies costing perhaps one-fifth the price of steel.



From Heresy to Conventional Wisdom

Last winter's widespread consumer outcry over the apple-crisping chemical Alar, a possible carcinogen, suggests how far the American public's attitudes have evolved in recent years. Questions once posed by Earth Day demonstrators have now entered the economic and social mainstream. Remedies from yesterday's political fringe are being embraced as the essence of practical wisdom today.

Recall that 20 years ago, vegetarian diets and organic foods were seen as oddball obsessions, of interest only to the counterculture clientele of small health-food stores. Today, high-fiber foods are fashionable, and large numbers of people avoid red meat in favor of semi-vegetarian menus, a trend apparent even in fast-food restaurants. Last year, a Louis Harris & Associates poll found that 84 percent of respondents would buy organic produce if given the chance, with 49 percent even willing to pay more for it.

In the early 1970s, recycling was handled by local activists with names like Ecology Action who set up small centers in remote parts of town and talked about a utopian future when biodegradable products would become the norm. Today, many towns and cities are instituting recycling programs with strong public support and even considering laws that require biodegradable packaging.

This shift in attitudes is probably not the total transformation of industrial society that visionary environmentalists have long advocated. Nevertheless, it represents a genuine improvement in patterns of American life that once seemed all but impossible to crack.

Oat-Bran Muffins and "Natural" Baby Food

What has transformed the heresies of yesterday into an emerging conventional wisdom? One factor is the explosion in scientific and medical information about the health advantages of eating better, exercising more, and avoiding dangerous substances. Heeding warnings about the causes of heart attack and cancer, millions of people have stopped smoking and cut down on sodium, cholesterol, and saturated fat. Where people feel they have some control over circumstances that affect them, they are willing to



*The
radical ideas of
20 years ago about
health and the environment
are the common
practices of
today.*

change their habits.

Sensing opportunities for profit, large corporations have also contributed to this shift in attitudes, by fostering new consumer tastes. Breakfast-food producers, for example, now vie to capture the whole-grain, high-fiber, neo-health-food market. Television ads portray the smart person as the one who eats the bowlful of fruit and fiber, while the dummy is the guy who hasn't gotten the message yet. A nationwide chain of donut shops recently plastered its windows with signs offering "Fresh Baked Oat-Bran Muffins."

This battle for the attention of health-conscious consumers has produced some surprises in formerly stable markets. Within the past year, two brands of "natural" baby foods have been introduced and sales are rapidly mounting. Parents seem especially sensitive to reports about cancer-causing

chemicals in children's food. Caught off guard by this development, spokespersons for established baby-food firms rush to appear on radio and television talk shows, insisting that their brands contain pesticide levels far below established government standards. Will "all natural" labels soon appear on their jars as well?

At the level of social policy, the important changes have less to do with evolving personal preferences and industry initiatives than with the acknowledgement of gnawing environmental problems. For the many communities that face mountains of solid waste and dwindling disposal sites, recycling has at last become a necessity. Even real estate developers, not a group known for environmentalist sympathies, have joined the call for better care of the land, air, and water; all too often when they break ground to build a new shopping mall these days, they discover an abandoned toxic-waste dump.

The Irony of Social Innovation

As ordinary citizens join large organizations in seeking environmental change, it is encouraging to watch new coalitions of citizen groups, businesses, nonprofit organizations, and government agencies come up with new social and technical inventions. The irony is, of course, that many of these proposals are far removed from the models of decentralized, voluntaristic activism that fueled the early environmental movement. Recycling, for example, is no longer a simple matter of sorting bottles, paper, and plastics into bins. It now involves sophisticated and costly technical processes for separating and processing waste materials.

Organic-farming techniques, as well, are often surprisingly complicated and capital-intensive. What to do about insects on lettuce? The old-fashioned method was to spray them with noxious chemicals. But Tanimura and Antle, a large produce firm in California, now sucks up the bugs with enormous vacuums. Contemporary solutions in "appropriate technology" can be surprisingly high-tech.

While many obstacles to positive change still loom before us—the Bush administration's lack of leadership on environmental issues such as the Alaskan oil spill comes immediately to mind—it is also clear that significant barriers of earlier times are gradually being lifted. As new policies and practices are debated, the common charge that "the public isn't ready for it" seems less valid each day. ■



LANGDON WINNER teaches in the Program on Science and Technology Studies at Rensselaer Polytechnic Institute. His most recent book is *The Whale and the Reactor*.

Self-Regulation of Science

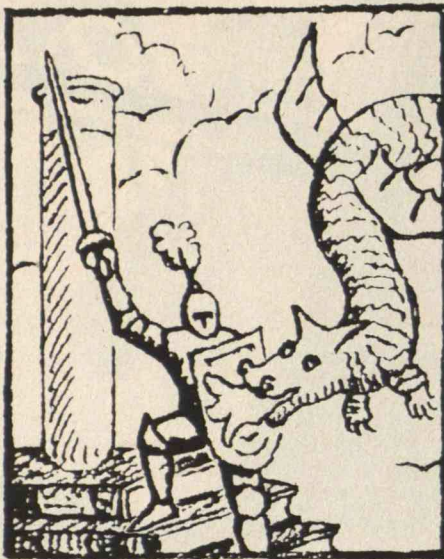
Last May, I went through an experience I hope never to repeat: having to defend my scientific research before an investigations subcommittee of the U.S. Congress. At issue were charges of misconduct and even fraud in the preparation of an article I coauthored with five colleagues and published in the journal *Cell* in 1986. At stake were not just our reputations but also a principle of value to all scientists—the self-regulation of science.

The worth of a piece of research is determined when scientific peers attempt to reproduce or, more commonly, extend an experiment's results. There are some, however, who want to substitute criteria and methods more appropriate for ferreting out corporate fraud than for evaluating a scientific investigation. They wish to impose rules that would not merely regulate science but regiment it. This poses a danger to the integrity of the scientific process.

Science by Subcommittee

Our research concerned an issue in one of the murkiest and most contentious areas of biology—immunology, or the study of the body's defense against germs. We had devised an experimental system that involved implanting a new gene into a mouse. We reasoned that through collaborative study with another laboratory, we might help clarify how the body's immune system decides what antibodies to make. The results suggested that for some unknown reason, the gene was causing havoc in the animal's immune system. Our paper provided some carefully hedged suggestions about what might have been happening.

A postdoctoral fellow who worked in the MIT laboratory that participated in the experiment challenged the conclusions of our paper. She was knowledgeable about the subject and, based on her reading of some experimental evidence, disagreed with our interpretation of certain data. Instead of discussing her concerns with the authors, she instigated two faculty reviews of our research—one at Tufts University, the second at MIT. The reviewers recommended that such disagreements be clarified through further research, leaving the issue to scientific



Reflections on a day spent testifying at a congressional hearing.

verification, where I believe it belongs.

The challenge escalated into a federal case when two self-appointed "scientific auditors" who are research scientists at the National Institutes of Health, Walter Stewart and Ned Feder, intervened. Neither Stewart nor Feder is an immunologist. They have done little significant science for many years. Nevertheless, they proceeded—in letters mailed to prominent scientists, in interviews with newspaper reporters, and in public lectures across the country—to accuse me and my colleagues not just of errors but of fraud. The two did not and could not prove their points in laboratory experiments.

When Stewart's and Feder's charges were taken up by staff members of the Oversight and Investigations subcommittee of the House Committee on Energy and Commerce, the unscientific review of our experiment escalated. The subcommittee staff employed the Secret Service to perform a forensic analysis of the laboratory notes of my colleagues. Of course, the Secret Service agents did not understand the science in question any more than did Stewart and Fed-

er or the subcommittee staff. The agents could analyze only paper and ink, not data and its interpretation.

A Chilling Effect

Such government intervention in the scientific process is potentially destructive. If this type of investigation had not been countered strongly, its threat would hang over all researchers causing fear and regimentation and, ultimately, stifling creativity. If each piece of science has to be so cut-and-dried that a congressional investigator can audit it, then research will become a defensive process. Too much energy will go into preparing for the audit rather than in grappling with the unknown.

I do not quarrel with the idea that scientists who receive public money need to accept some level of regulation, particularly financial auditing to assure that the money is handled appropriately. We already do. The existing procedures monitor the way we obtain and keep track of the money we spend, assure that we operate in a safe and healthy environment and treat employees fairly, spell out standards for animal care, and define the ethics of human experimentation. But auditing how scientists conceive, perform, and report on experiments is a different issue, one that violates the autonomy of the individual researcher.

Many dismiss the scientist's plea for autonomy as self-serving. They argue that scientists require more oversight because fraud is a serious problem and scientific institutions have been unwilling to identify and discipline those who commit it. Such skepticism has been fueled by some recent cases of scientific misconduct that have been handled poorly, almost amateurishly, by the sponsoring institutions.

Although my experience in science suggests that actual scientific fraud is quite rare, there is little doubt that the research community must take self-policing more seriously if it is to retain its historic and necessary autonomy. We must be alert to indications of fraud and misconduct, and ready to discipline the perpetrators.

If we are to be more open, then the media and the public must also understand that occasional cases of fraud do not mean that the scientific process as a whole is suspect. Too often, individual instances of misconduct have become the excuse for broad criticisms of science—which certainly is a disincentive to openness.

Continued on page 79



DAVID BALTIMORE, a Nobel laureate, is director of the Whitehead Institute for Biomedical Research and professor of biology at MIT.

A new process dramatically reduces Printed Wiring Board (PWB) manufacturing time. The process, called Just-In-Time, helped trim the time to manufacture PWBs at Hughes Aircraft Company from four or five months to just ten days. Just-In-Time reduces the cycle times, the time a product spends moving or waiting, by organizing the work flow so everything progresses in unison. Work is planned so that each PWB operation is completed as the next operation finishes its work and is ready to take on the next assignment. All job hardware arrives just in time for the next work to begin on it. Many manufacturing areas at Hughes have adopted similar systems to shorten cycle times.

An advanced computer-controlled system provides radar detection and tracking of all aircraft approaching Japan's borders. The sophisticated defense system, designated the Base Air Defense Ground Environment Extension and the result of a joint development effort between Nippon Electric Corporation (NEC) and Hughes, is proving to be an excellent high-technology system for protecting Japan's borders and sea lines. Should unidentified aircraft be spotted, operators inside command centers can direct fighter interceptors to visually identify the aircraft or take necessary defensive actions. Hughes built Japan's initial automated air defense system in the 1960s.

Television programming will be available with picture quality similar to 35 millimeter motion picture film and sound quality similar to a compact disc. Hughes and North American Philips are working together to test a high definition television (HDTV) system for satellite delivery of HDTV to American homes. Research will include a mobile HDTV Viewing Center to advance research of the new technology and conduct engineering and picture-quality rating tests. Two Direct Broadcast Satellites will be launched by Hughes in the early 1990s to beam a total of 32 channels of television programming direct to one-foot home satellite antennas throughout the United States.

Transistors built using CMOS/Sapphire on Silicon (SOS) technology operate at higher frequencies than ever reported for silicon MOSFET devices. These Metal-Oxide-Silicon Field Effect Transistors, developed by Hughes, demonstrate cutoff frequencies greater than 20 gigahertz. The combination of mature digital technology with complementary silicon MOS microwave devices will allow the building, on a single chip, of such circuits as digitally controlled microwave shifters or Microwave/Millimeter Wave Monolithic Integrated Circuit amplifiers.

Hughes Technical Services Company (HTSC™), a subsidiary of Hughes Aircraft Company, is rapidly expanding its contractor operations and logistics support to meet individual and customer program requirements. Upcoming military contracts to be supported by HTSC include simulators for the T-45 Goshawk, Fleet ASW Team Training and Landing Craft Air Cushion. HTSC presently needs engineers, programmers and field service technicians with experience in simulation in order to keep pace with new contract requirements. Qualified candidates may send resumes to: Hughes Technical Services Company, Trainer Support, Dept. S2, P.O. Box 90962, Long Beach, CA 90809. Equal opportunity employer. Proof of U.S. citizenship required.

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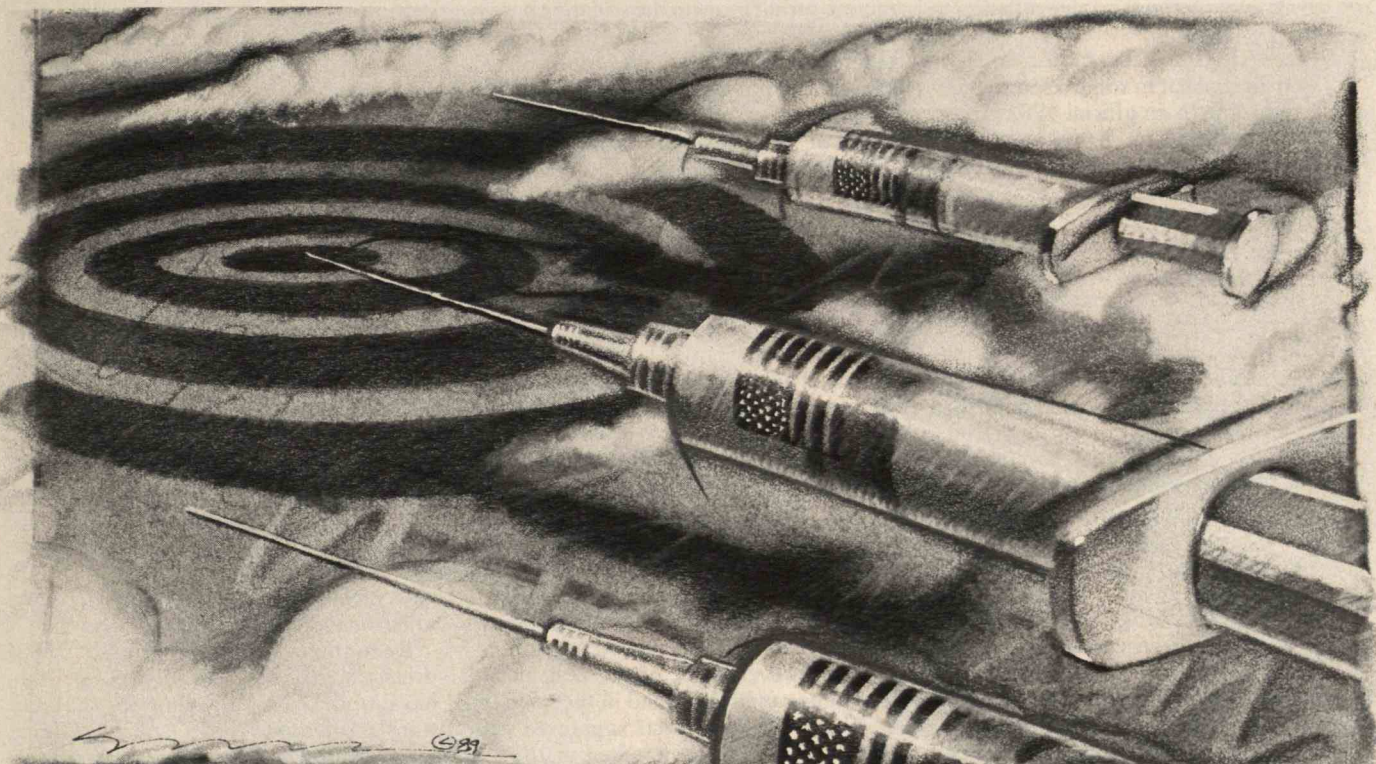


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BY KEITH R. YAMAMOTO

Retargeting Research on Biological Weapons



FOR years the U.S. government held that biological weapons were not suited for conventional warfare because they were slow-acting and difficult to restrict to enemy populations. In 1969, saying that such agents “may produce global epidemics,” President Richard Nixon ordered the destruction of U.S. biological-weapons stockpiles and imposed a moratorium on research, production, possession, and use of biological weapons.

But new technologies that have emerged during the last decade, such as recombinant DNA, have initiated a striking change of opinion about biological weapons in Washington. Between fiscal years 1983 and 1987, the budget for the Army’s Biological Defense Research Program alone grew fivefold, to \$90 million. The Department of Defense (DOD) is now second only to the National Institutes of Health

*Congress should
turn over DOD funds
for germ-warfare studies
to a civilian agency
concerned with
diseases.*

in federal support for biotechnology. DOD is using the money to produce and test biological agents, develop vaccines and drugs that can protect against a range of pathogens, and stockpile millions of doses of these products.

The Pentagon’s dependence on a “vaccine strategy” as a broad defense against biological warfare cannot succeed. Administering in advance a vast array of vaccines would be logistically and medically untenable. And vaccines are useless if given after the fact.

Even worse, although DOD claims the research is defensive—and therefore per-

mitted under the 1972 Biological and Toxin Weapons Convention—the program subverts the distinction between defensive and offensive research. It raises suspicions among other countries about U.S. intent and destabilizes biological arms-control efforts. And it subjects the U.S. public to health risks from development, testing, and risk-assessment programs.

When Does Defensive Become Offensive?

Devising novel pathogens would appear to be a clear-cut violation of the Biological and Toxin Weapons Convention, which forbids offensive biological weapons research. Yet DOD is doing exactly that in the name of defensive research. It says it will study the resulting agents to produce antidotes in the event that U.S. forces are targeted by biological weapons.

In a Senate committee hearing this past May, Col. David Huxsoll, commander of the U.S. Army Medical Research Institute of Infectious Diseases, suggested that defensive research includes the growth of a pathogen in limited quantities. Offensive research, he said, involves trying to increase an agent’s ability to spread disease

KEITH R. YAMAMOTO, professor and vice-chairman in the Department of Biochemistry and Biophysics at the University of California, San Francisco, chairs a review group at NIH, the Molecular Biology Study Section. With Charles Piller he wrote *Gene Wars: Military Control Over the New Genetic Technologies* (Beechtree/William Morrow, 1988).

DOD's biological-research program discourages participation by innovative researchers.

or developing methods to disseminate biological weapons.

Both of Huxsoll's criteria for offensive research are present in some research projects. According to an official 1983 report, the objective of one Army-sponsored study was to modify bacteria that commonly occupy the human gut so that they could "produce any desired . . . level of pathogenicity." Other questionable research has been performed on the organism that causes botulism. Army-funded scientists found a way to conserve the bacterium's toxicity to the nervous system yet decrease its ability to produce an immune response. And an Army report published in 1985 boasts that "for the first time, T-2 mycotoxin [which can kill mice] was successfully disseminated."

DOD's apparent strategy of disguising offensive research as defensive virtually demands that other nations, large and small, develop similar programs. They may view U.S. biological-weapons research with alarm particularly because the United States is the undisputed world leader in biotechnology and biomedical research. According to DOD officials, at least 10 countries are doing biological-weapons research, but more detailed information is classified.

The DOD research might also pose a public-health risk, despite emphatic denials from the Pentagon. In an April 1989 environmental-impact report, for instance, DOD promised "virtually total protection for the external environment." Such a statement does not tally with the sorry history of past DOD biological-weapons testing programs. Only after a 1977 Senate hearing did DOD acknowledge that in the 1950s it engaged in massive open-air tests in which it released vast quantities of mildly pathogenic bacteria over San Francisco Bay and in the New York City subway system. The tests appear to have triggered disease outbreaks that caused at least one death, according to the Senate testimony. Now the Army plans to use Dugway Proving Ground, just outside Salt Lake City, as an aerosol and pathogen testing facility. DOD's confidence this time around only increases concern about possible errors at the site.

Even if all these problems could be eliminated, we would still be left with a research structure that does not lend itself to good science. In writing *Gene Wars: Military Control Over the New Genetic Technologies*, coauthor Charles Piller and

I found problems with the scientific quality of many of the 329 DOD-sponsored biological research projects we evaluated. Many seem poorly conceived and of questionable significance. This results in a waste of fiscal and intellectual resources.

Rather than having investigators develop ideas for research, DOD sets narrowly defined goals and invites scientists to submit proposals that satisfy these objectives. Such targeted research programs tend to discourage participation by the most innovative researchers.

In addition, many of the reviewers of proposed projects appear poorly qualified. For example, of the eleven people evaluating molecular-biology proposals for the Army Research Office in 1987, only one was a molecular biologist. And the review findings are merely advisory. DOD will fund projects that are evaluated negatively if they are deemed of sufficient military importance.

Moreover, by law all DOD biological-agent studies are unclassified. Yet the results from even some of the best-funded programs cannot be found in the scientific literature. Of 33 projects supported with \$19.8 million and undertaken in 1987 at the Army Medical Research Institute of Infectious Diseases—a prime site for work under the Biological Defense Research Program—11 resulted in no published papers. For comparison, during the same period researchers in my university department received about \$7 million in federal support for 42 projects. All yielded papers (in fact, a total of 165).

Transfer the Funds

DOD funds for biological studies should be transferred to the National Institutes of Health (NIH), a consortium of 13 research institutes charged with investigating human diseases and disabilities. Importantly, the stated mission of the Biological Defense Research Program (BDRP)—understanding disease mechanisms and developing vaccines and drugs for infectious diseases—could better be achieved under NIH programs. The goals of the institutes of environmental health and allergy and infectious disease are virtually identical to those of the BDRP. After all, many of the diseases of concern are primary killers in underdeveloped nations.

I don't make this proposal simply because I have ties with NIH (I head the group of scientists that reviews molecular-

biology proposals) but because that agency operates under review and oversight principles that have consistently produced creative and important research. Under the NIH system, investigators usually initiate proposals rather than respond to contract offerings. These proposals then undergo a rigorous two-stage peer-review process.

Vigorous and open dissemination of research findings—a prerequisite for NIH funding—would undermine the feasibility of conducting research on biological weapons. And without a DOD-funded program, other nations would not be as likely to finance such studies.

NIH oversight would also require careful safety checks before any research began. The NIH review group that I head, for instance, closely monitors projects' safety. And in another review level, scientists and lay representatives sit on advisory councils that consider safety and other factors.

Recognizing the problems of DOD oversight, Rep. Wayne Owens (D-Utah) has introduced a bill calling for the same transfer of funds that I am advocating: H.R. 2371 would turn over most DOD biological-research funding to NIH. Since biological weapons remain a legitimate threat, at least from terrorists, DOD would continue to control studies such as the testing of detection devices and protective clothing. However, the Pentagon might be constrained to carry out most, or all, of these programs with harmless "simulant" agents such as *E. coli*. They are not only safe but are typically more sensitive for tests.

H.R. 2371 deserves strong support from the scientific community. This is a critical time to contact congressional representatives, especially Rep. John Dingell, who chairs the Energy and Commerce Committee, which is considering the bill. Both as individuals and as members of scientific societies and educational institutions, scientists should also refuse sponsorship from the Biological Defense Research Program. And they should vigorously oppose military financing for other biological studies related to weapons development.

Pentagon support for this research is not justified. Transferring the relevant funds to NIH would lead to high-quality research that could have enormous positive effects on health, especially in less developed countries. The result might be a healthier, safer world. ■

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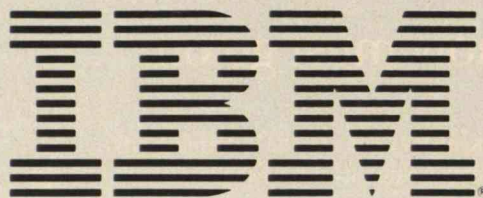
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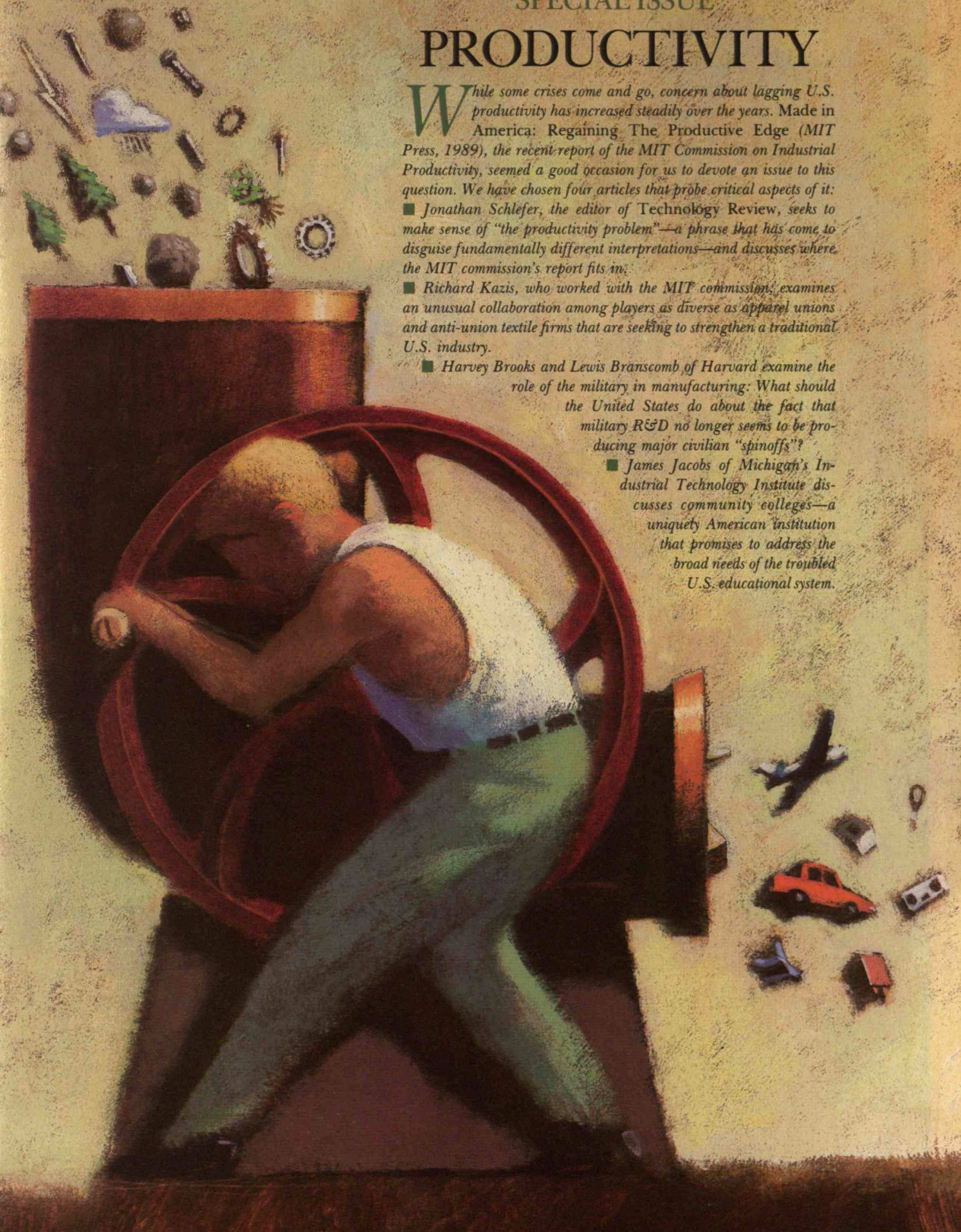
PRODUCTIVITY

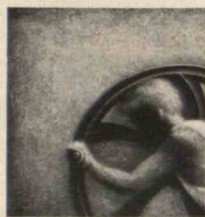
While some crises come and go, concern about lagging U.S. productivity has increased steadily over the years. Made in America: Regaining The Productive Edge (MIT Press, 1989), the recent report of the MIT Commission on Industrial Productivity, seemed a good occasion for us to devote an issue to this question. We have chosen four articles that probe critical aspects of it: ■ Jonathan Schlefer, the editor of Technology Review, seeks to make sense of "the productivity problem"—a phrase that has come to disguise fundamentally different interpretations—and discusses where the MIT commission's report fits in.

■ Richard Kazis, who worked with the MIT commission, examines an unusual collaboration among players as diverse as apparel unions and anti-union textile firms that are seeking to strengthen a traditional U.S. industry.

■ Harvey Brooks and Lewis Branscomb of Harvard examine the role of the military in manufacturing: What should the United States do about the fact that military R&D no longer seems to be producing major civilian "spinoffs"?

■ James Jacobs of Michigan's Industrial Technology Institute discusses community colleges—a uniquely American institution that promises to address the broad needs of the troubled U.S. educational system.





Making Sense of the Productivity Debate: A Reflection on the MIT Report

THE first two decades after World War II were an era of strong growth for U.S. productivity. The next two decades have been an era of strong growth for analyses of U.S. productivity. Concerns began in the late 1960s when the annual increase in productivity—workers' hourly output as measured by the Bureau of Labor Statistics (BLS)—dropped from 3

Assessing the recent MIT findings requires answers to basic questions about why—and whether—productivity matters.

percent to 2 percent. By the early 1970s business observers were looking for solutions to the “crisis” in productivity.

Soon productivity growth dropped to 1 percent a year, and there it remained.

Everyone proposed a different explanation. Economists focused on culprits measured by government statistics. A major cause of the productivity slowdown, ac-

BY JONATHAN SCHLEFER



Both inflation-adjusted hourly wages and hourly output of U.S. workers have stagnated by standard measures. Most analysts believe that poor productivity forces businesses to restrict wages. Others say

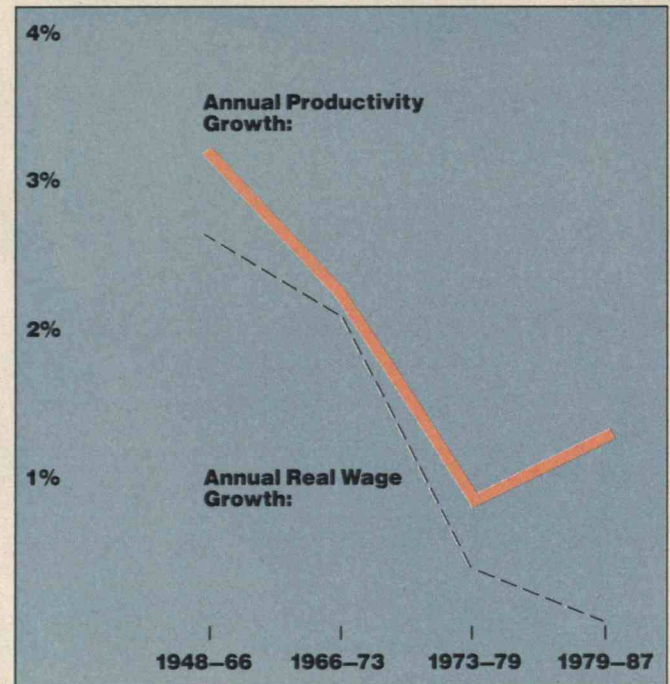
that because the U.S. minimum wage is so low, manufacturers have little incentive to increase productivity. (Real wages from Bowles, Gordon and Weisskopf, *Journal of Economic Perspectives*, Winter 1979.)

cording to a 1979 *Fortune* article, was that business investment grew "a feeble 1.4 percent" annually from 1973 to 1978, compared with 3.9 percent from 1947 to 1973. The article pointed to oil-price shocks that triggered inflation, leading to high interest rates. Firms reduced investment in new equipment, making workers less productive. Economist Alan Greenspan projected that if oil prices behaved, capital investment would surge in the 1980s. They did, but it did not. Now chairman of the Federal Reserve Board, Greenspan has been keeping interest rates high, restraining inflation but also investment.

Business managers and editorial writers discovered almost personal sins that they thought were tainting the production system. An early culprit was loss of the work ethic. At the General Motors Lordstown plant, management charged workers with slowdowns and sabotage, and in 1972 employees held a wildcat strike that was termed "industrial Woodstock." Later the focus turned to the executive suite. In a widely read article published in 1980, "Managing Our Way to Economic Decline," Robert Hayes and William Abernathy of the Harvard Business School argued that managers adept at paper profit-making were failing at manufacturing.

In the late 1970s and early 1980s, big government weighed in as a malefactor. Conservatives pointed to excessive regulation, environmental laws, and even affirmative action. Liberals blamed high military spending. Almost everyone could join ranks against too many lawyers. President Jimmy Carter ran against government and began deregulating airlines. President Reagan was the deregulation president, but nearly a decade after he took office, the productivity crisis is very much alive. Just before President Bush's nomination, the *New York Times* editorialized that the major U.S. economic problems have one "common root": "productivity growth has collapsed."

In May the MIT Commission on Industrial Productivity added its report, *Made in America: Regaining the Productive Edge* (MIT Press), to this long-running debate. The commission, appointed by MIT President Paul Gray, was composed of prominent faculty including a former MIT president, the provost, the dean of engineering, and economist Lester Thurow, dean of the Sloan School of Manage-



ment. Michael Dertouzos, director of the Laboratory for Computer Science, was chairman. Robert Solow, Nobel laureate in economics, was vice-chairman, and Richard Lester, who has written widely on problems of the nuclear power industry, was executive director. Suzanne Berger, head of the Political Science Department, also played a critical role.

The commission accepted the idea that investment in new equipment is dampened by high interest rates but rejected the lists of personal sins. It is hard to see why American managers would suddenly become greedy or workers lazy. Nations with stronger productivity growth have tough environmental regulations and often higher government spending. U.S. military budgets are relatively smaller than in the 1950s.

The commission concluded that the American productive system is not being eroded from without but has itself become obsolete. Mass production, once a powerful engine of growth, now perversely impairs U.S. industry. In a competitive world where customers demand high-quality, specialized products, U.S. firms need to regain traditions of custom-tailoring. They can do so by harnessing computer and communications technologies to modern production machinery.

As in West Germany or Japan, management should focus over the long term on continually im-

*Poor productivity has been
blamed for everything—inflation, trade deficits,
and now children growing up in poverty.*

proving product design and manufacturing. Workers must contribute substantively to these improvements, so they need more responsibility and better education. Units within firms need to cooperate—for example, the design department should create products with few parts so manufacturing can produce them efficiently—and the firms themselves need to cooperate with suppliers and customers. In a global economy, that means understanding foreign languages and cultures better.

This view of the productivity problem can now be considered mainstream. The first printing of *Made in America* sold out within a week. John Young, president of Hewlett-Packard, and Donald Ephlin, vice-president of the United Automobile Workers, equally praised it. Motorola and Alcoa required senior executives to read it. Many ideas crystalized by the MIT commission have been in the air: in January, months before the study came out, Treasury Secretary Nicholas Brady announced that his primary goal is to influence U.S. industry to focus on the long term.

After two decades of false starts, does the commission have the answer? The question is, the answer to what? In attempting to weigh different views about productivity, I was struck by how charged the word has become and how many meanings it has accrued. The title of the MIT report conjures up the 1950s and 1960s, when “made in America” symbolized not just good productivity figures from the BLS (other nations actually did better) but an era of prosperity. When I spoke with members of the commission about what the problem is, economist Robert Solow talked about 3 percent a year growth versus 1 percent, electrical engineer David Staelin expressed concern about floods of imports purchased with borrowed money, and political scientist Suzanne Berger said that if productivity growth continues to stagnate, the nation “will somehow be impoverished.”

Outside the commission, the meaning of the productivity problem is even more diverse. In the 1970s the business press saw it as the root of that era’s villain, inflation. In the 1980s it became the source of the trade deficit. The *New York Times* editorial mentioned earlier claimed that poor productivity lies behind everything from rising foreign purchases of U.S. assets to the high percentage of American children growing up in poverty.

Citing government statistics that investment is at historical levels and manufacturing productivity

growth is higher than during the 1950s and 1960s, some conservative economists dispute that there is a problem. Economists on the left ask who will buy all the new cars and tape recorders. The low “capacity utilization” of the 1980s—the current business cycle has the highest average percentage of idle factories and workers of any since World War II—means that a more competitive United States might only aggravate cutthroat worldwide competition and protectionism.

The “productivity problem” has so many solutions partly because the problem itself has so many formulations. Trying to gauge recommendations of the MIT commission and others led me to identify four fundamental approaches. “Stagnation” theory maintains that there is a glut of goods that cannot be sold, so productivity improvements are irrelevant. “Supply-side” economics holds that powerful forces of innovation are already producing healthy productivity growth. “Macroeconomics” asks if the market is functioning properly to foster investment and boost productivity. The “institutional” approach seeks to correct problems in the actual structure of the production system.

I will examine these four approaches in more detail. The MIT commission accepts both the macroeconomic and the institutional views, emphasizing the latter. However, it is helpful to look at the stagnation and supply-side theories first. Although they are considered fringe—supply side was poorly understood during its few years in the limelight—they state their assumptions with great clarity. These assumptions underlie and help illuminate mainstream views.

Productivity Is Irrelevant

“Stagnation” theory, which concludes that the issue of productivity growth is unimportant in the United States today, has affinities to the insights of John Maynard Keynes. He analyzed an irony of the Depression that eluded other economists because economic theory of the time declared it to be impossible: while much of the population lived in poverty, enormous productive capacity stood idle. The factories and farms that had provided wealth during the 1920s did not suddenly evaporate, but they shut down, since people had less and less money to purchase goods. As businesses closed, even fewer people had money, and on the cycle went. “Effective demand” was lacking. Typical Keynesian measures to promote demand during a recession are deficit

U.S. industry fails to use its existing capacity because demand is stagnant, according to one theory. Increasing U.S. productivity

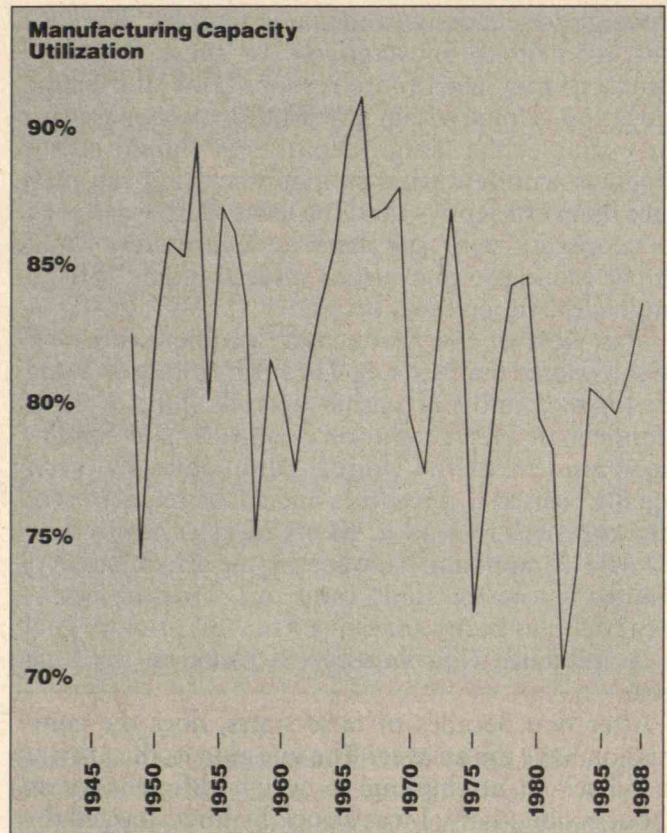
would merely intensify cutthroat competition for limited markets. (Data: Federal Reserve Board)

spending by the government and unemployment insurance, which give people money to buy goods.

Stagnation theory, articulated by Paul Sweezy and Harry Magdoff of the respected journal *Monthly Review*, constitutes an important branch of Marxism. It holds that stagnation arises from contradictions within capitalism. One contradiction is captured in a story (these days told mainly by economists) about Walter Reuther, long-time president of the United Automobile Workers. Pointing to some new automated equipment, Henry Ford II asked, "Walter, how are you going to get those machines to pay dues?" "Henry," replied Reuther, "how are you going to get them to buy cars?" Capitalists invest profits in new technologies to increase productivity. Before long, higher productivity results in more goods, but workers cannot buy them all. After a while each capitalist, unable to sell the inventory, stops investing and lays off workers. As this happens across the economy, even fewer workers can buy products and demand drops. The spiral leads to a depression.

Sweezy and Magdoff maintain that stagnation settles in as capitalism matures and large corporations dominate the market: these firms tend to "overaccumulate" savings, for which they cannot find profitable capital investments. Lagging investment leads to insufficient demand for plants, machinery, and raw materials, thus increasing unemployment and reducing demand for consumer goods as well. The economist Robert Heilbroner, who has often drawn from Marxist thought, wrote recently in *The New Yorker* that "the lurking question of economics, certainly during the present century, has been whether a capitalist economy will experience general gluts, under whatever name."

The question, then, is not why the economy is in trouble now but what triggered the economic expansion after World War II. Magdoff and Sweezy point to a number of factors. The need to rebuild depleted equipment at home and war-shattered economies overseas called for enormous capital investment. Rapid growth of automobile and related industries such as steel and oil created employment and further investment. Highways and interstates were built; suburbia mushroomed. The civilian aircraft industry and the airport system were established. U.S. products, particularly automobiles, were exported to markets around the world. But by the 1970s, expansion petered out, leaving excess production capacity. Utilization of manufacturing ca-

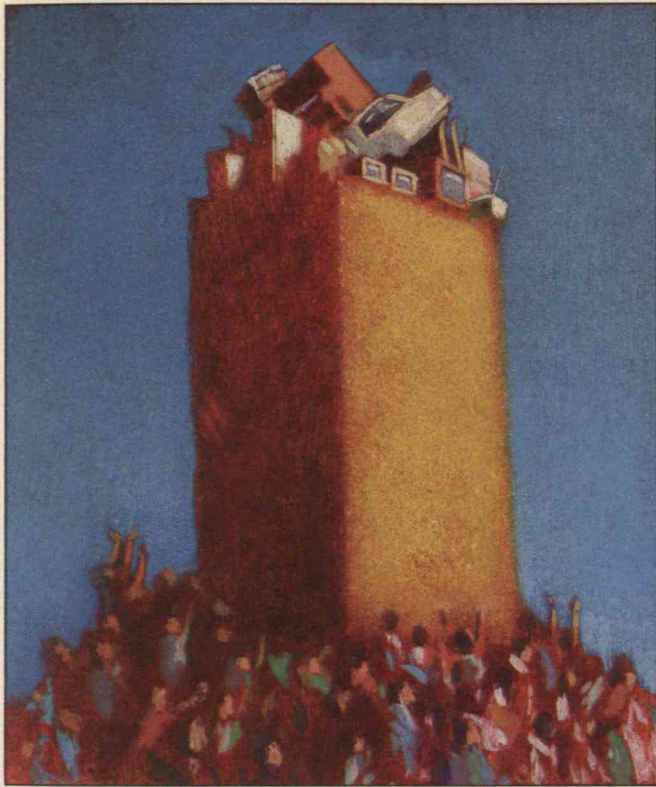


capacity, as measured by the Federal Reserve Board, was 84 percent in 1988, poor for a business-cycle expansion.

Since stagnation theory holds that the problem is excess production capacity, it concludes that policies proposed by many economists and the MIT commission to stimulate investment may only make matters worse. Consider their effects on a global level. If U.S. firms buy new technologies to increase productivity, they may capture market share from Japanese or Brazilian firms, but the foreign companies will respond in kind. Cutthroat competition for a limited world market is likely to intensify protectionist measures on all sides. Protectionism could further limit the world market: economists agree that it aggravated the Depression of the 1930s.

Sweezy and Magdoff argue that high U.S. productivity on the farm and in the factory has already provided a large enough surplus of goods to support the enormous growth of the service economy. Some services, such as education, health, and entertainment, enable people to live better. Others do not: advertising, telemarketing, and speculation in stocks, commodities, and real estate—the sorts of

*Stagnation theory says the
problem is industrial capacity that firms can't use
and goods that they can't sell.*



activities the sociologist Thorsten Veblen called “the wasteful occupations.” The continued burgeoning of the service economy “proves beyond a doubt that the productivity of labor in the commodity-producing areas has been growing by leaps and bounds,” write Sweezy and Magdoff.

Magdoff and Sweezy see a need for productivity growth in the Third World—it still lacks the basic capacity to support adequate living standards—but they see no such need in the United States. In this country there are other problems. In view of the increasing polarization of rich and poor, how can the economic system more fairly distribute what it produces? And how can the nation use existing production capacity? Based on World War II experience, Sweezy and Magdoff calculate that existing labor and capital resources could produce 40 percent more than they do now. On that scale, “a 1 or 2 percent increase in productivity is peanuts,” Sweezy told me.

Productivity Is Everything

The supply-siders who inspired the early Reagan administration see productivity as the central economic question. Their diametric opposition to stag-

nation theory turns on a chicken-and-egg question—does supply create demand or demand create supply? Supply-siders believe that supply—the production of goods—inherently creates a demand, putting money in the hands of workers who are able to buy the goods.

This idea is known as Say’s law, after Jean-Baptiste Say, a French follower of Adam Smith. When a product is manufactured, the proceeds are paid to those who made it—salaries to workers, materials costs to suppliers, interest to financiers, and profits to owners. “Across an entire system, purchasing power and producing power can always balance,” writes George Gilder in his influential book *Wealth and Poverty*. “There will always be enough wealth in an economy to buy its products.”

In his recent *New Yorker* article, titled “The Triumph of Capitalism,” Robert Heilbroner gives what is in effect a supply-side answer to Marxism: “The long-term process of expansion has bypassed saturation by discovering or creating new commodities.” Suppose it is the late 1970s and U.S. capitalism is facing a glut. At the same time, entrepreneurs at Apple and other companies are realizing that they can put a microprocessor and some chips in a plastic box, attach a TV screen, and produce a new product: the personal computer. These entrepreneurs rent space, hire workers, and purchase supplies, injecting money into the economy. Their computers sell, so they hire more workers, rent more space, and purchase more supplies. Eventually, IBM sees that it too can enter the field. This proves a powerful force for economic expansion.

The economy hinges on the spirit of enterprise, Gilder believes, the leap of faith that starts new industries and expands economic horizons. What causes a depression is not a mathematical lack of demand but a failure of “animal spirits.” Gilder quotes Keynes himself: “Only a little more than an expedition to the South Pole is [a new enterprise] based on an exact calculation of benefits to come. Thus, if the animal spirits are dimmed and the spontaneous optimism falters, leaving us to depend on nothing but a mathematical expectation, enterprise will falter and die.” Demand exists, Gilder writes, “in the imagination of the entrepreneur.”

A populist streak in Gilder’s thinking that champions entrepreneurs and decentralization is not incidental. Multinational corporations plan production after assessing demand from government statistics. Entrepreneurs take risks more like explor-

ers. In contributing innovative products that society seeks and jobs that it requires, such individuals are characteristically generous. That is Gilder's response to Khrushchev's charge that capitalism is immoral because it is based on greed.

The supply-side conclusion about the productivity crisis is that it doesn't exist. BLS figures for manufacturing productivity indicate 3.5 percent annual growth during the 1980s—better than during the 1950s and 1960s, and better than most other industrialized countries except Japan. Many mainstream economists and even the BLS itself now believe these figures to be inflated (a point I will return to), but Gilder holds that they underestimate actual performance.

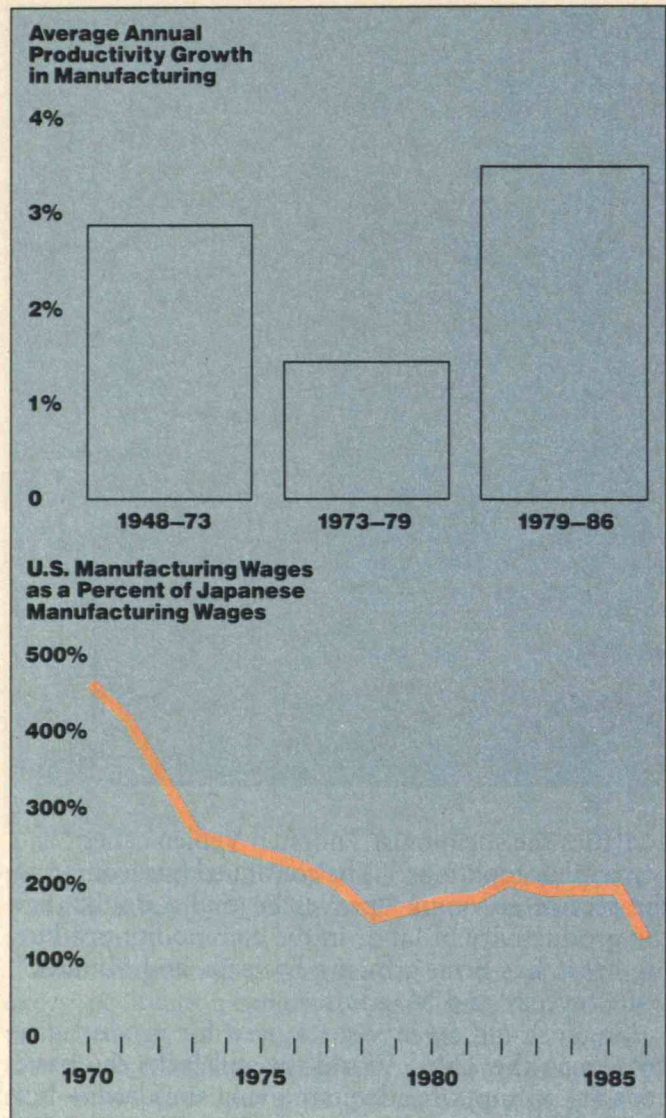
He notes in *The Spirit of Enterprise* that in 1957, Western Electric's semiconductor plant in Allentown, Pa., employed 4,000 workers, each of whom produced 5 transistors a day. In 1983, the plant still employed 4,000 workers, but each produced 5.3 million transistors a day—a productivity increase of 106,000,000 percent. However, government statistics measure output by price adjusted for inflation, so they concluded that output—hence productivity—barely increased. They similarly underestimate the output of industries such as computer manufacturing that use chips. A “deflator” to account for technological advance has been applied recently, but Gilder considers it inadequate.

Gilder's point is fundamental, not merely technical. Productivity statistics do the worst job at assessing the most innovative sectors of the economy. When USX produces another ingot of steel, that is duly tabulated. When an innovative software package is developed, that cannot be adequately measured. This flaw is fatal since innovation is the lifeblood of capitalism: “wealth consists not chiefly in things but in thought.”

Since entrepreneurs are the source of productive growth, the government has minimal roles to play, according to supply-siders. First, keep taxes low so as not to discourage the entrepreneurial leap of faith. After the capital gains tax cut of 1978, “all the indices of the entrepreneurial economy moved massively up, as a long backlog of innovations at last found significant funding,” writes Gilder. Second, says Gilder, establish clear, reasonable regulations. If society wants clean water, it should set clean-water standards, but let entrepreneurs vie to provide cheap, effective technologies to meet the standards. The third recommendation is to stop blocking immigra-

Figures from the Bureau of Labor Statistics indicate that U.S. manufacturing productivity is higher than during the 1950s and 1960s. But an indirect measure—comparing U.S. and Jap-

anese manufacturing wages—leads to a more sobering conclusion. (Relative wages from Hatsopoulos, Krugman, and Summers, *Science*, July 15, 1988.)

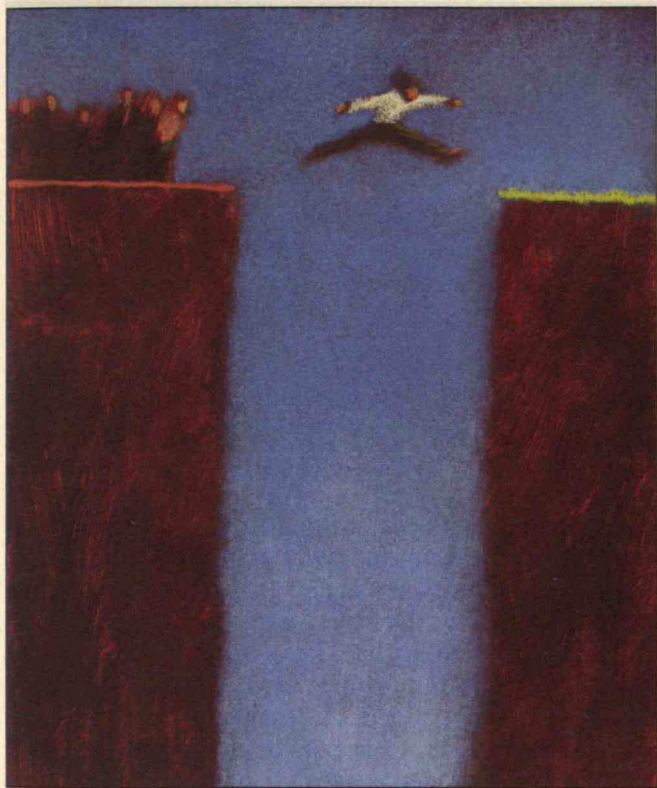


tion. Immigrants are the hardest working, most innovative Americans.

Getting the Macroeconomy Right

Mainstream approaches to productivity—particularly macroeconomics, which I consider first—often appear prone to factionalism. Macroeconomists are notorious for disagreeing with one another. Robert Hall, a conservative at the Hoover Institution, recently noted in the *New York Times* that the economic expansion of the 1980s is still strong: “investment in new equipment for businesses”—critical to productivity growth—“is at record levels in

*Supply-siders hold that
the entrepreneurial leap of faith keeps
our economy afloat.*



relation to national output.” Robert Solow, a liberal on the MIT commission, is less sanguine that the business cycle will go on expanding or that investment is adequate. According to the commission’s figures, while U.S. investment is at historical levels, it is below that of economic competitors such as Japan and West Germany.

However, macroeconomists agree in their basic approach. (I will sometimes simply call them economists, and when I use either term, I am really referring to the mainstream of the profession—there are individuals that my descriptions do not apply to.) Macroeconomics holds that the “invisible hand” of the marketplace, in Adam Smith’s phrase, provides a powerful means of regulating the economy, efficiently supplying what is needed to those who need it. Liberals see imperfections in the market that government policies can redress. Conservatives see fewer market imperfections and advocate less intervention. But all economists have a healthy respect for market functions that are deeper than they appear on the surface.

Economists seek to get economy-wide (“macro”) factors such as tax levels, the money supply, ex-

change rates, and interest rates “right.” If the market operates efficiently, firms, unions, and government agencies at the “micro” level will take care of the rest, including productivity. Hence economists do not study the institutional details—such as whether the National Science Foundation should fund more research on production technologies—that were the MIT commission’s main focus.

Economists’ disagreements have less to do with esoteric calculations of the trade than with a simple assessment of the current situation. For example, the economy has generated an enormous number of jobs in the 1980s, but many of those jobs pay very little. Conservatives are content that the cup is half full. Liberals are worried that it is half empty. If the cup is half empty, then poor productivity must be a major factor. When productivity has grown well, as in the 1950s and 1960s, U.S. firms have raised hourly wages. When it grows poorly, firms must hold wages down to make a profit.

The liberal view has been articulated by George Hatsopoulos, chairman of the board of Thermo Electron Corp., Paul Krugman, professor of economics at MIT, and Lawrence Summers, professor of economics at Harvard. In a widely read article in *Science*, they pay particular attention to manufacturing productivity. This is what the United States must improve to become more competitive—exports of services are only a tenth of total imports. Hatsopoulos, Krugman, and Summers argue that BLS measures of manufacturing productivity are misleadingly benign. They cannot adequately account for the widespread perception that the quality and innovativeness of American goods, in sectors ranging from consumer electronics to industrial machine tools, have declined. The real lag in U.S. productivity can be gauged by comparing American and foreign manufacturing wages. In 1970 U.S. wages were 4.5 times those in Japan, but by October 1987, they were only 1.1 times as great—an enormous drop yet still not enough to keep U.S. firms competitive.

Many economists also believe the BLS figures showing strong manufacturing productivity have significant technical problems. For example, the value of imported semiconductors was underestimated. Since they were used in large volume in many products, manufacturers’ apparent “value added,” and hence productivity, looks better than it actually is. The Commerce Department itself has announced that it will revise productivity growth downward but has not said how far.

Macroeconomic handicaps such as the high value of the dollar have increased U.S. imports in industries such as automobiles and consumer electronics. However, commercial aircraft

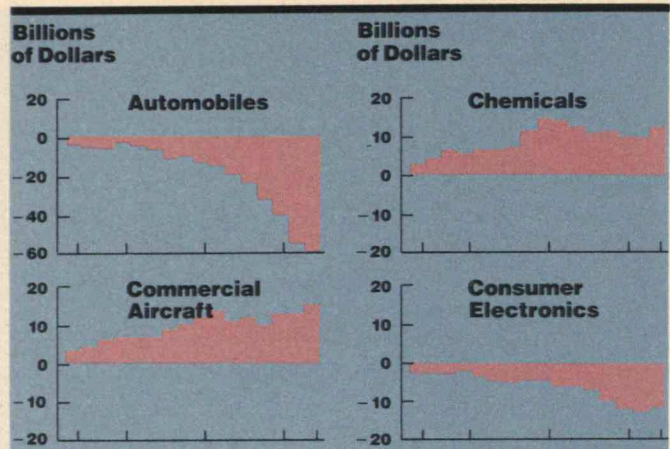
and chemicals, subject to the same handicaps, are net exporters. The MIT commission concludes that the success of these manufacturers must stem from their business practices.

Hatsopoulos, Krugman, and Summers say the culprit is the cost of capital (a figure combining the cost of borrowing money and issuing stock). A high cost of capital discourages companies from investing in new plants and machinery. It also discourages "investments" in intangibles, such as accepting low profits while establishing a foothold in a new market. The authors calculate that in 1985 the cost of funds (discounting inflation) was 6 percent for U.S. firms and only 1.5 percent for Japanese firms. A U.S. company could sacrifice a dollar as long as it made \$1.20 in three years. A Japanese firm that sacrificed a dollar could wait twelve years to make \$1.20. Short-term horizons may "come to seem cultural," say Hatsopoulos, Krugman, and Summers, but they result from the cost of capital: "The appropriate strategy for lengthening business planning horizons and encouraging long-term investments is not to criticize corporate cultures but to change the market incentives that shape them."

Although Hatsopoulos, Krugman, and Summers do not give specific prescriptions in their *Science* article, changing the market incentives generally means balancing the federal budget, to begin with. Deficits directly increase the cost of capital as the government competes with other borrowers for savings. Deficits also have an indirect effect. They tend to cause inflation by providing cash to government employees and contractors, who bid up prices. The Federal Reserve Board responds by raising interest rates to restrict the amount of cash that banks can lend out. This keeps the inflationary trend under control, since it curtails consumers' ability to bid up prices. However, a balanced budget would make it possible to check inflation with lower interest rates. Many economists agree that, for practical purposes, balancing the budget means raising taxes, but to promote investment, they would allow breaks for individuals who save and corporations that purchase capital equipment.

The Search for Better Practices

Many analysts have focused on problems with the structure of U.S. industries rather than the overall economy. *In Search of Excellence* and other business books propose radical changes, not simply ways of earning a few more cents on the dollar. University researchers, too, have examined "institutional" issues ranging from top management to the shop floor. For example, while Hayes and Abernathy focused



on executives who are trained in financial management and judged on quarterly profits, Warren Seering, a mechanical engineer at MIT, described a technological misadventure. Pressured to help U.S. industry compete with "cheap foreign labor," researchers tried to build armies of humanoid robots with finger-like grippers and mechanical shoulders, elbows, and wrists. General Motors discovered that even at union wages, a worker can grab a handful of bulbs and stick them in a dashboard far more economically than such a contraption.

The MIT commission adopted the institutional perspective. But first, faced with a decade of research on the institutions of the U.S. production system—and two decades of cues and miscues about U.S. productivity in general—the commission members had to figure out what problem they were trying to solve. In 1986, when they set about their task, the U.S. trade deficit loomed large. The economists on the commission explained to the engineers that the trade deficit could not be equated with poor productivity. Lester Thurow pointed out that Bangladesh runs a trade surplus for the simple reason that no one is willing to lend it money. In principle, the engineers understood that if the value of the dollar fell, the trade deficit would eventually disappear. But since this implied that the U.S. standard of living would also have to fall toward that of Bangladesh, the engineers viewed the "solution" as semantic trick. They found such a situation unimaginable in human and political terms. Many of them continued to feel that the trade deficit measured a real failure in the productive ability of the nation.

In the end, the commission broadened its definition of productivity significantly beyond the disputed

*The MIT commission
articulated the idea of a new
industrial paradigm.*

BLS figures. Productivity came to embrace factors that are difficult to measure—the poor quality not only of U.S. products but of the entire productive system. In some 500 interviews and 150 visits to factories, members of the commission saw these problems repeatedly. Electrical engineer David Staelin described to me how he asked managers to show him their newest, best machinery. The newer it was, the more likely it came from West Germany or Japan. Managers were unwilling, even unable, to tell him what percentage of their products they had imported and slapped labels on.

The commission accepted the argument of Hat-sopoulos, Krugman, and Summers that the high cost of capital reduces productive investment. The question was whether this is the preeminent factor—whether institutional problems of U.S. industry are mere artifacts stemming from the cost of capital. If so, the commission might as well have announced the fact and disbanded.

However, the group saw problems with this argument. If the cost of capital explained everything, why were some industries, such as commercial aircraft and chemicals, healthy? Boeing alone has practically 50 percent of the world market for commercial aircraft, and after difficulties in the 1970s, the chemical industry is making a strong comeback. The commission believed there are institutional reasons: senior executives at aircraft and chemical companies have detailed engineering knowledge and have been willing to invest in technology. Another problem with ascribing everything to the cost of capital is that although Japan's is significantly lower than that of the United States, West Germany's has not been so different, yet the country has been industrially successful.

Finally, no matter why the structure of U.S. industry has become obsolete, macroeconomics cannot fix the problem by itself. Since mass production treats workers as adversaries, increased competition only induces managers to step up the pressure. To break away from this framework, a firm has to consciously change its basic organization. There is no market in manufacturing systems that will induce it to do so.

Having agreed on the importance of institutional as well as macroeconomic factors, the commissioners embarked on detailed studies of eight industries—automobiles, chemicals, commercial aircraft, consumer electronics, machine tools, steel, textiles, and (lumped together) semiconductors, computers,

and copiers. The auto study, relying on groundwork laid by the MIT International Motor Vehicle Program, was the first to bring the manufacturing system into focus. From the 1920s through the 1970s, U.S. automakers learned to produce long runs of standard cars with occasional cosmetic changes. Precisely delineated jobs, which allowed firms to use relatively unskilled workers, were enforced by union contracts. Even professionals developed narrow skills—as door-lock engineers, for instance. Suppliers and employees alike were jettisoned during slow periods, and a certain level of defects was expected—the bad parts were thrown out.

Japan's now-fabled Ministry of International Trade and Industry (MITI) urged its producers to emulate Detroit, but they balked. Their markets were too small, and they had to produce a variety of models, so they developed a flexible production system. While an entire press line in Detroit might stamp out right front fenders for Chevrolets, taking up to 24 hours to change dies, Japanese firms learned to change dies in five minutes several times in a shift. Since firms produced small batches, defective parts were intolerable. Firms maintained strong relations with workers and suppliers to ensure near-perfect quality. The result was less waste and higher productivity.

Here was a fundamentally different productive system that provided for custom tailoring. That theme emerged from the seven other industry studies and embodied many of the individual lessons brought to light in the 1980s. For example, the flexible production system requires managers to focus on technological change, answering Hayes and Abernathy. The system also requires engineers to enlist workers' intellects, rather than replace them with robots of the sort that Warren Seering criticized.

Perhaps the commission's most important contribution has been to forge the idea of a new industrial paradigm. However, it did not emerge full-grown from the minds of 16 commissioners. The word "paradigm" has been part of the MIT vocabulary since Thomas Kuhn of the Linguistics and Philosophy Department published *The Structure of Scientific Revolutions* in 1962. The notion is that a revolution does not consist of numerous piecemeal changes but grows from a fundamental shift in perspective. In 1984 *The Second Industrial Divide*, by Michael Piore and Charles Sabel of the Economics and Political Science departments, persuasively applied the idea to industrial institutions, describing

Is investment in capital stock sluggish because of high interest rates? Some economists point out that the slowdown began during the 1973-79 business cycle, when

real interest rates fell. Firms couldn't sell what they produced, so they utilized less of their existing capacity and had little incentive to invest.

the paradigm of "flexible specialization," particularly in Italy and West Germany. The commission substantially generalized Piore and Sabel's work.

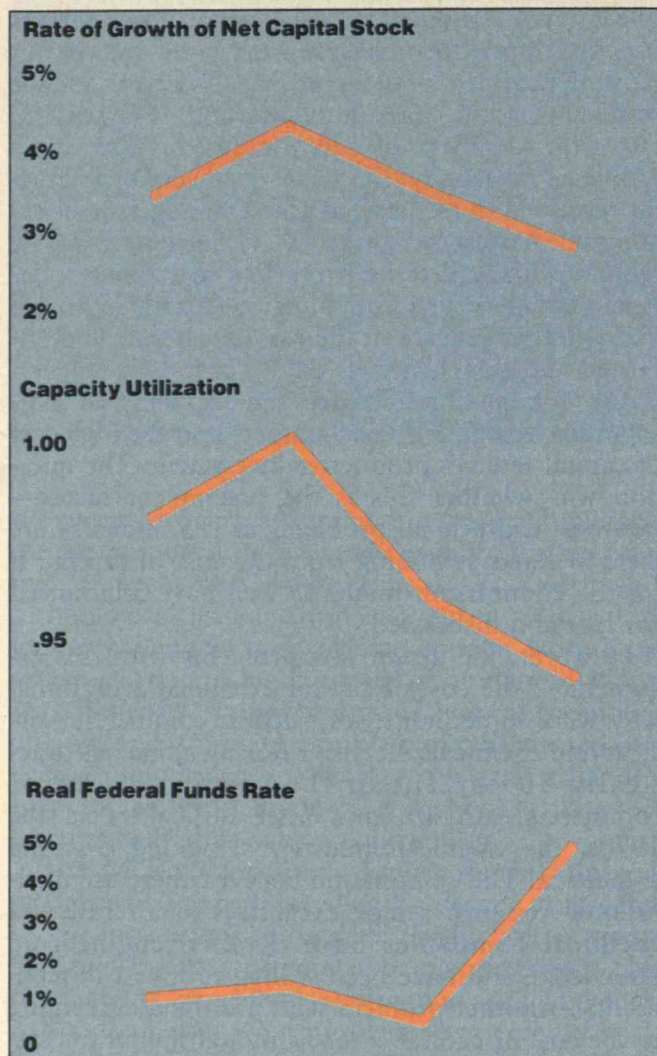
Which Comes First, Supply or Demand?

Supply-side economics emphasizes the supply of new products; stagnation theory emphasizes the need to sustain demand. These are such fundamental themes that mainstream views about productivity inevitably make an implicit choice between them. Whether an approach to solving the productivity problem will actually be adopted, and what its ultimate effects will be, depend a great deal on that choice.

The commission's macroeconomic and institutional approaches have supply-side underpinnings. This follows directly from the recommendations. The commission advocates macroeconomic measures to reduce the cost of capital and increase the supply of funds available for investment. As firms use these funds to purchase new plants and equipment, and as they adopt the new industrial paradigm, they will improve their productivity and sell more products. (If they did not increase sales, the whole exercise would be futile.) The question then becomes who will buy the additional goods.

Suppose the managerial reforms and increased investment do not generate additional demand—demand beyond what exists today—to purchase the goods. U.S. industry can still become more competitive by capturing markets now supplied by other nations. That may well be a legitimate goal regarding Japan. However, it does not seem so legitimate regarding Brazil, for example. That country also competes directly with U.S. manufacturers, even in advanced products such as some types of computers, and it has a much lower standard of living and a more troubling international debt—troubling not only to itself but to the world banking system. Many Third World nations have already been required by the International Monetary Fund to reduce consumption—and hence demand—in exchange for debt relief. They will suffer even more, and the world will suffer, if the United States produces high-quality, specialized products merely to beat other nations in a competition for limited markets.

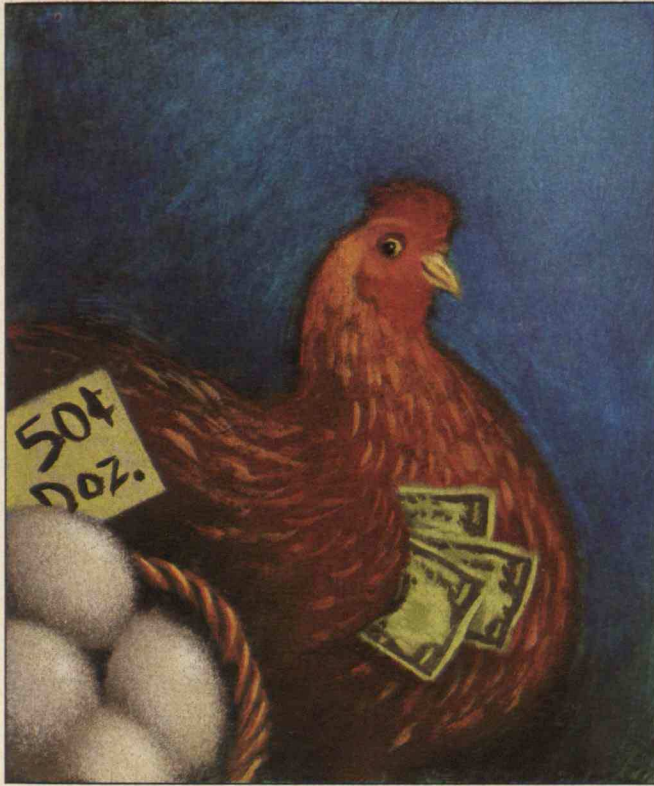
The assumption behind the MIT commission recommendations must therefore be that by accepting long-term risks, investing in workers and capital, and producing more useful and less expensive products, firms will create demand. If this supply-side theory



is correct, the overall market will expand, and the world will benefit.

The commission's assumption is challenged by an institutional and macroeconomic view of productivity that shares stagnation theory's concern about demand. This view is maintained by liberal-left economists David Gordon of the New School for Social Research, Samuel Bowles of the University of Massachusetts, and Thomas Weisskopf of the University of Michigan. They agree that productivity growth is essential for improving the quality of life, whether the concern is higher income, fewer working hours, or a cleaner environment. "Why should this generation suddenly abandon objectives of increasing productivity that have fueled past generations?" Gordon told me. He believes it is not easy to "redistribute a fixed pie"—that is, give the poor and

*Which comes first,
supply or demand? Deciding what to do about
productivity depends on the answer.*



middle class an adequate share of wealth in a stagnant economy. "The struggle over that fixed pie is intense."

However, unlike the MIT commission, these three economists see the large amount of industrial capacity that is already idle as a more long-standing impediment to investment than the high cost of capital. Consider the situation in the 1970s and early 1980s. Many economists claimed there was a capital shortage even then and proposed similar cures: to tax consumption, meaning the American consumer, and give tax breaks to business for investment. As *Business Week* noted, "It will be a hard pill for many Americans to swallow—the idea of doing with less so that big business can have more."

Bowles, Gordon, and Weisskopf attacked this approach in *Beyond the Waste Land* in 1983. They pointed out that real interest rates were actually negative during the 1970s: you could borrow money at less than the inflation rate. Business wasn't investing because it already had excess capacity. The three economists have averaged capacity utilization over post-war business cycles to highlight long-term trends. The index they use, established by the President's Council of Economic Advisors, varied from

0.98 to 1.00 before 1973 but fell to 0.96 from 1973 to 1979. (As with most economic indices, the absolute values mean little. What matters is relative change.)

During the 1980s the cost of capital has been high, as the MIT commission states, but there seems to have been plenty of money for mergers and speculation. Gordon, Bowles, and Weisskopf argue that capital investment has been sluggish largely because it has not promised good profits. Capacity utilization has been the lowest since World War II—0.94 from 1979 to 1987, according to the index. The Federal Reserve's restriction of the money supply has contributed to the problem. After all, when consumers have less money, there is less demand, and industry must cut production.

In this situation, merely reducing the cost of capital and providing tax breaks for investment, as the MIT commission recommends, will do little good, say Gordon, Bowles, and Weisskopf. In *Beyond the Waste Land* they note that after the Reagan administration secured tax cuts in 1981, giving extremely favorable treatment to investment, capital spending actually declined 6 percent. "Company executives don't shout, 'Whoopee! Now where can we invest this money?'" the *Wall Street Journal* quoted a machinery executive as saying. "They need an opportunity that promises a good profit."

The three economists would address the issue largely through institutional change, and though they do not examine the industrial system in much detail, what they propose—more managerial innovation and better motivation for workers—does not seem fundamentally different from what the MIT commission has articulated. Where they differ from the commission is that they doubt firms will adopt a new industrial paradigm just because MIT tells them to.

Consider the German apprentice system. The MIT commission admires the way this institution provides broad training. Since only a minority of apprentices stay on with the employer who trained them, they probably contribute only half as much to the firm as they cost. Why do corporations maintain the system? "Little would one recognize from the commission's report the huge power of unions in Germany," Gordon notes. Fewer and stronger than in the United States, unions share power with corporations and the government in reaching decisions on major issues such as apprenticeships.

Similarly, the MIT commission seems to admire

Airline deregulation flies in the face of what the MIT commission recommends.

the regulatory framework that used to govern U.S. airlines: "While a government-business partnership was creating a new commercial-aircraft manufacturer in Europe [Airbus], the government-business partnership in the U.S. was fraying." Deregulation put a premium on cost-cutting. Airlines reduced or eliminated large engineering staffs that had spent thousands of hours evaluating designs with manufacturers. The industry began to allow financiers to purchase aircraft and pushed development risks onto manufacturers. All of this flies in the face of the MIT commission's recommendations, but the group does not propose reinstating regulation.

"The commission represents a naive and myopic view of how power is distributed in the United States and how corporations behave," says Gordon. He and his colleagues believe broad political change is necessary. Otherwise, firms will have no incentive to do the kinds of things MIT advocates.

Gordon, Bowles, and Weisskopf would, for example, give workers more power, increasing minimum wages and unemployment insurance, and decreasing working hours—matters where European unions have a substantial say. Such changes would motivate U.S. firms to increase productivity. As long as the U.S. minimum wage (adjusted for inflation) is so low, both by historical standards and in comparison with Europe, corporations don't need more productive operations. It's much easier just to take advantage of the large pools of cheap labor. Increasing wages and unemployment insurance would also provide cash to consumers, thus strengthening demand and using more industrial capacity.

The MIT commission calls for less sweeping changes for several reasons. An obvious one is that the commissioners did not consider themselves qualified to propose a political platform. More important, they sought to make recommendations that business, labor, and government could actually adopt. The German and Japanese systems of broad-based training within firms are admirable, but why not try to build on strengths of the U.S. system, such as community colleges (*see page 66*)?

The commission believes that American industry can duplicate success stories such as Chaparral Steel, a "minimill" in Texas that is the lowest-cost producer of its class in the world. U.S. companies could learn from Chaparral's flat structure (only 4 different levels of employees) and close ties between engineering and sales (engineers *are* the sales force). Much as foreign observers came to the United States

in the early twentieth century to learn about mass production, Americans may be able to import the more flexible German and Japanese system.

The commission even argues that U.S. firms will be forced to change. "The technologies for mass producing standard goods consigned workers to tasks that made few demands on their mental capacity and skills," says the report. "Today and in the future, effective use of new technology will require people to develop their capabilities for judgment, for collaboration, for planning, and for the analysis of complex systems." The new productive system could well sweep the industrialized world just as mass production did. Certainly, the time is ripe for major change, as is evident from the desperate search for better practices that business books cater to.

One could question how thoroughly the commission's new production system—"economic citizenship" for workers, longer time horizons, increased cooperation within and among firms, and improved education—will be adopted. Paul Krugman makes an analogy to the British who discovered assembly-line production in the United States in the 1920s. Imperial Chemical Industries might have seen that Americans had more capital and better education, but it could do nothing about that. What it could do was to emulate the manufacturing system. The British learned this system, and their living standards did rise—to a point. But they never addressed deeper problems, notably their educational system. The United States risks following that example.

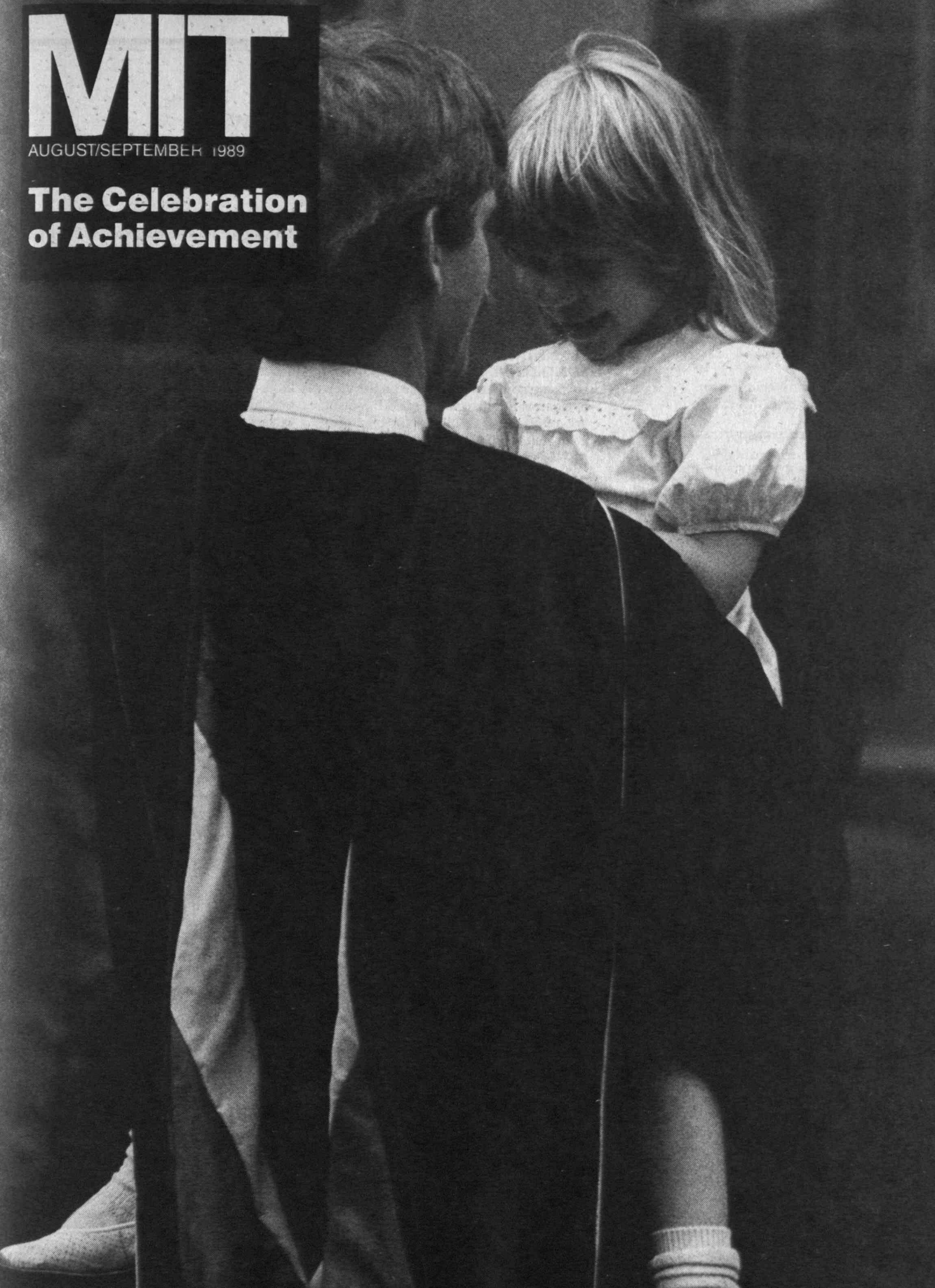
After the initial meetings of the MIT commission, the economists essentially put their profession aside and joined the engineers in examining the institutions of production. They uncovered a rich institutional story and made sensible proposals to industries for becoming more productive. However, as Suzanne Berger observes, they did not tie this institutional story to an argument about the overall economy. If the proposed reforms succeed, will they increase the general welfare, aggravate cutthroat competition, or do something entirely different?

No mainstream theory answers this question either. The terrain is largely empty between the micro level of institutions and the macro level of overall supply and demand, profits and employment. As long as that remains the case, the jury is still out on what the MIT commission recommends—and other institutional remedies proposed by the business press, best-selling authors, and high-priced lecturers—ultimately mean for the world. ■

MIT

AUGUST/SEPTEMBER 1989

The Celebration of Achievement



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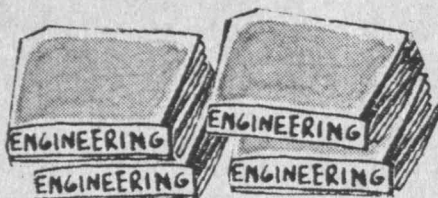
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COVER:

The memory of the students slaughtered in Tiananmen Square hung over MIT's Commencement this year, but it could not completely overwhelm the usual atmosphere of family festivity. The Review offers a special salute to graduates who earned their degrees while coping with the responsibilities of parenthood.

Taking Issue with Wilson and Sanders



PLANNING SHOULD BE LONG-TERM, NOT EDUCATION

I was intrigued by the article on the views of Dean of Engineering Gerald L. Wilson, '61, entitled "Four Years Not Enough to Educate an Engineer." (*January 1989, page MIT 18*). In my 35 years as an engineer in industry, I have found that the engineers produced by U.S. colleges are very capable. The fact that industry in this country finds itself in a difficult position in the competitive world marketplace is not a sign that our engineering is poor or that our engineering schools need to change their courses or increase the number of years of study. Rather, it is a sign of the "this year's bottom line" attitude of the management of U.S. businesses.

I have found that U.S. production engineers meet the challenges given to them by management and produce precisely what management wants and specifies. But over the past 35 years, the number of engineers in management has decreased and the number of financial managers has increased. U.S. companies will continue to have difficulty meeting international competition until management becomes more concerned with making better products and having a product for the future, rather than trying to squeeze out every last penny of profit this year.

I find Dean Wilson's remarks rather self-serving: it is obviously to his advantage to hold students in college as long as possible. This is especially true in light of the reduced numbers of students in the pool now that the "baby boom" has passed. My son is completing a degree in accounting at a New England college, and I was not particularly surprised to hear that his college is now suggesting that an accounting degree should require five years instead of four.

Rather than planning how to fill their classrooms, U.S. colleges should be assisting the nation's businesses in recognizing that the "long-term" is what counts, not this year's bottom line.

WILLIAM S. RAWLINGS, '54
Glastonbury, Conn.

ESP UNDER FIRE

Although I am a firm believer in the freedom of the press, I was both amazed and upset that *Technology Review* would print an article such as "Applied ESP" (*M/J, page MIT 40*). I hope it was merely a lapse in editorial judgment, because you appear to have given credence to the claims of a psychic without presenting an opposing view.

It is regrettable that the American public is being besieged by a host of self-proclaimed psychics who claim to possess extraordinary powers capable of transcending the limits of scientifically verifiable knowledge. Granted, some psychics might be sincere in their belief that they possess such powers, but their attempts to prove them on the basis of scientifically controlled experiments have proven futile to date.

I refer your readers to the Committee for the Scientific Investigation of Claims of the Paranormal (CSICOP). Fellows of CSICOP include Carl Sagan and Stephen Jay Gould; Steven Pinker, director of the Center for Cognitive Science at MIT, is a consultant. I do not speak officially for CSICOP, but I do subscribe to their publication, the *Skeptical Inquirer*. CSICOP fellows have investigated scores of paranormal claims, and, to date, none of the claims have been verified. What's more, there have been cases of proven fraud. Various CSICOP fellows continue to offer monetary rewards to anyone who can demonstrate paranormal phenomena.

Technology Review

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under controlled experimental conditions, but after about 12 years, no one has yet been able to claim a reward.

It is disconcerting to note that, according to a National Science Foundation poll, millions of this nation's adults are scientifically illiterate. Worse, not only do our high-school students rate below their counterparts in other industrialized nations in science and mathematics, but many are being lured into beliefs such as satanism and witchcraft.

MIT could do its share in stemming a rising tide of mysticism, occultism, and pseudoscience in this country by instituting a mandatory freshman subject in epistemology, with emphasis on the history of science and the evolution of the scientific method. Such a subject should be designed to instill in students a scientific spirit that extends to all aspects of life, rather than merely to one's field of specialization. MIT should also make an effort to instill such a spirit outside its walls, especially in elementary and high schools.

GEORGE H. THERIAULT, '43
Dobbs Ferry, N.Y.

We want to express our deep disappointment at the embarrassing credulity displayed by the author of the article on "Applied ESP." Contrary to the excerpt from Pete Sanders' book, there is no reliable evidence for the existence of ESP (see, among other references, the essays by Alcock and Hansel in the Summer 1984 edition of *The Skeptical Inquirer*). Moreover, Sanders' program to "teach people techniques for developing their psychic skills and self-healing abilities" very likely leaves him open to charges of fraud. The offhand reference to the superstring theory as closing "the gap between science and spirituality" is the sheerest flummery.

We take some consolation in the fact that the review of the Sanders book will not be read by those who buy *Technology Review* on the newsstand. Even so, it is hard not to feel some shame on behalf of the entire MIT community. Certainly, it is quite reasonable for the *Review* to question the context and effects of scientific research; but in order to achieve that goal, it is first necessary to distinguish science from pseudoscience. We hope that in future issues the magazine will display less charity toward charlatans like Sanders.

MICHAEL A. EISENBERG, G
ANDREW BERLIN, G

ELIZABETH BRADLEY, G
ARTHUR GLECKLER, '89
MICHELLE LEE, G
JONATHAN REES, G
MITCHEL RESNICK, G
GUILLERMO ROZAS, G
FRANKLYN TURBAK, G
KENNETH YIP, G
FENG ZHAO, G
Laboratory for Computer
Science, MIT

In excerpts from Peter Sanders' book *You Are Psychic!*, the author cites work by J.B. Rhine at Duke University and work at the Stanford Research Institute as examples of "successful" ESP experiments. But Rhine's work was discredited decades ago, and it has been thoroughly documented how Puthoff and Targ at SRI were tricked by Uri Geller.

Sanders says that he was impressed by scientific facts and ideas that seemed to defy common sense, including relativity, electron tunneling, and neutrinos. But the experiments that support these ideas can be replicated by anyone who chooses to try them, even if the experimenters are highly skeptical at first (as many were). In contrast, psychic research is a field in which more than 100 years of research have yet to produce one single experiment that can be regularly reproduced by skeptics.

Sanders states that "Life situations are a much better setting for practicing and exploring ESP . . . than laboratory conditions." Of course; experiences under those conditions, called "anecdotal" by scientists, are indeed ideally suited to misinterpretation, sloppy record-keeping, forgetting bad results, uncontrolled side effects, subjective validation, and so on. These are exactly the conditions that produce belief in astrology and laetrile. Sanders seems to be utterly ignorant of the history of science that causes scientists to insist on controlled experiments.

I suppose it's nice to know what our fellow graduates are doing. However, the publication of this book by one of its graduates is an embarrassment to MIT, reflecting poorly on the Institute's ability to instill fundamental scientific knowledge in its students. I would have preferred that *Technology Review* bury this announcement in the Classes section of the magazine and spare us the two-page spread.

LAWRENCE J. KRAKAUER, '63
Wayland, Mass.

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Commencement 1989 Shadows of Beijing

By David Hamilton

Even as the day broke clear and sunny on the morning of June 5, newspapers were landing on front porches bearing the grim news that

would shadow the morning's Commencement ceremony: army troops in the People's Republic of China (PRC) had fired on pro-democracy demonstrators in Beijing's Tiananmen Square, killing hundreds, if not thousands, of unarmed students.

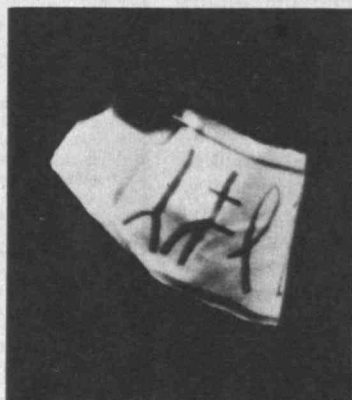
The horrifying events cast a somber light on the normally celebratory occasion, not least because an estimated 180 students and scholars from the PRC currently attend MIT. Far larger numbers of ethnic Chinese from the United States and around the world also study here. Although explicit displays of mourning were isolated, the deaths of so many peers of MIT's 1,776 degree recipients could not help but charge the atmosphere with sorrow and a deep sense of solidarity.

President Paul E. Gray, '54, for instance, rewrote his original remarks on "the clouded state of science in this country" to commemorate the student protestors. "The horror of the weekend's events in China remind me once again—as they remind us all—that the future of the world depends fundamentally on people having a

voice, having sovereignty over their lives," he said.

Castigating Chinese leaders for their unwillingness to listen to their own people and for their ensuing brutality, Gray expressed his hope that the students' sacrifice would not have been in vain.

"No nation can long suppress the call to freedom that comes from those on whom its future so critically depends," he said. He went on to urge graduating students to support the values of democracy in their own lives, values



Sadness: remembering the deaths of Chinese students.

he evoked with the metaphor of the university forum—"a place where any idea can be discussed, where truth is not an ideology, where reasoned debate and impassioned discourse are cherished."

In another gesture of solidarity, Gray, commencement speaker Paul Tsongas, Provost John M. Deutch, '61, MIT Corporation Chairman David S. Saxon, '41, and former President Howard W. Johnson all wore black armbands in sympathy with the students in Beijing, as did many graduates and members of the audience. Saxon, Graduate Student Council President Scott Y. Peng, and Rev. Scott Paradise also memorialized the slain students in their remarks and prayers.

Similarly, Tsongas prefaced his address with a moment of remembrance for the Chinese protestors, saying,

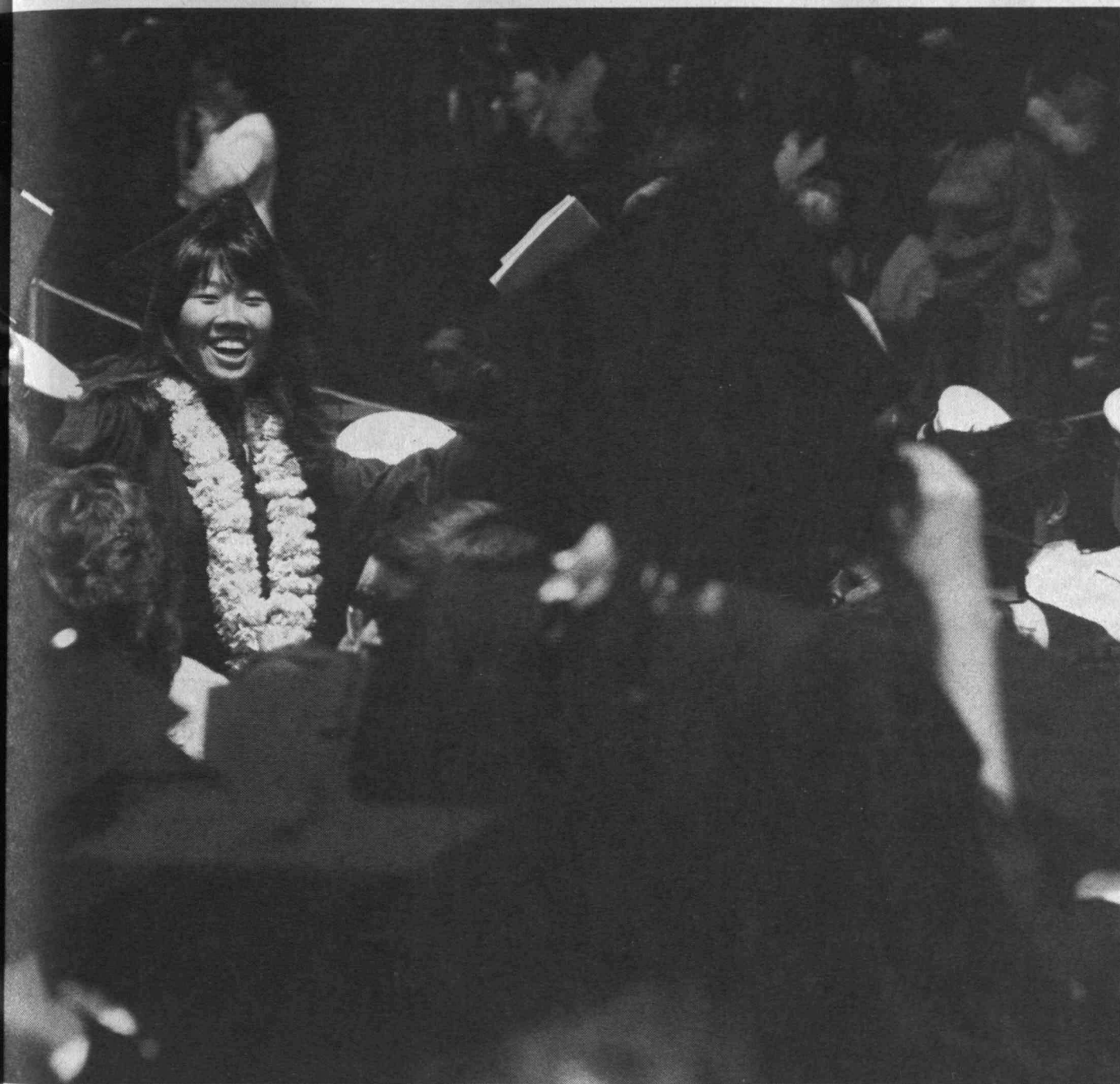


And joy: "I made it!"

"The authorities in China know full well that history will record their brutality. They have prepared for that legacy. What they are not prepared for is that history will also record their futility."

Tsongas, former U.S. senator and current chairman of the state Board of Regents of Higher Education, went on to leave the graduates with two rather unsettling messages. In the first, more personal, message that reflected his own encounter with cancer at 42, he considered the "vagaries" of life and the different paths that graduates would travel. "Some of you will live

DAVID HAMILTON, '89, is an intern at Technology Review.



long lives; some of you, sadly, will die young. Some of you will achieve great professional success. Some of you will never live up to your promise."

Instead of dwelling upon the negative and unpleasant side of life, he suggested, graduates should embrace the "old bromides" of family, community, love of others, and hard work. "Don't fear your mortality, because it is this very mortality that gives meaning and depth and poignancy to all the days that will be granted to you."

Tsongas' second message addressed the broader issue of the

American economy and the importance of coming to grips with new competitive challenges from Europe and Japan. He decried a widespread fascination with financial engineering and called for a renewal of intellectual values and learning, saying, "The only weapons in this war of your lifetime are the weapons of the mind."

Outside Killian Court, in three locations across the campus, Chinese students from MIT, Harvard, and Boston University collected signatures on petitions to President Bush and the Senate Foreign Relations Committee

that condemned the Chinese massacre and called for an end to "such crimes against humanity."

In Lobby 7, Tsongas' words seemed to echo throughout the domed space: "It is this very mortality that gives meaning and depth and poignancy to all the days that will be granted to you." Students in Beijing had measured their own mortality against the ideal of democracy and chose the latter. Even as the graduates and their families celebrated their achievements, the magnitude of that sacrifice continued to reverberate. ■



Everything Out There Is Not Fine

By Paul Tsongas

Before I begin, I think we should pause to remember the slain students in China. The authorities in China know full well that history will record their brutality. They have prepared for that legacy. What they are not prepared for is that history will also record their futility. In this era of the global village, the tide of democracy is running. And it will not cease, not in China, not in South Africa, not in any corner of this earth where the simple ideas of democracy and freedom have taken root. To the students in China—our brothers, our sisters—I say that we are with you, and we pray for your deliverance.

I would like to express my appreciation for your kind invitation to speak to you today. But I must say I accepted it with some hesitation. Thirty-one years ago I graduated from high school: I don't remember who spoke then. Twenty-seven years ago I graduated from college: I don't remember who spoke to me then, either. And 22 years ago I graduated from law school. Since that was the sixties, I didn't go to my graduation, so by definition I have no idea who spoke to me there. I fear that I'm going to be the great trivia question at your reunion.

I have two thoughts that I would like to leave with you today. A myth that's often perpetuated at commencement is that only hope and promise lie beyond the halls of academe. "Don't worry, be happy. Everything is fine. . . ." But everything out there is not fine.

When I look back at my graduating class, I remember co-equal faces, with co-equal hopes and co-equal futures. The co-equality soon ended, and life took over.

PAUL E. TSONGAS is the chairman of the Massachusetts Board of Regents of Higher Education and a former senator from Massachusetts. (He is also the nephew of Alexander Tsongas, '28, and Anthony Tsongas, '25.)

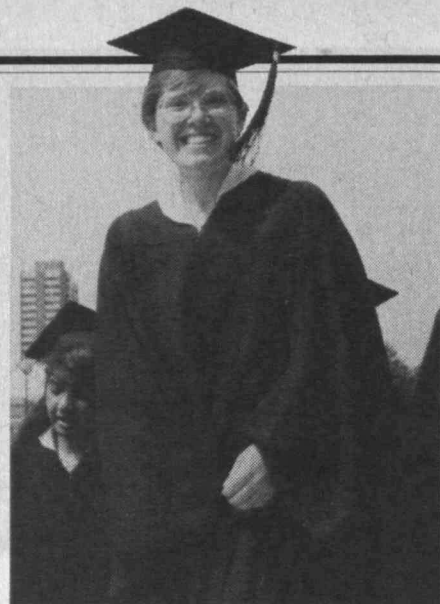
Life with its oddities, its surprises, its uneven effects, its—dare I say it—law of averages. The fact is that your class, as mine, will experience the same vagaries. Some of you will live long lives. Some of you, sadly, will die young. Some of you will achieve great professional success. Some of you will never live up to yours. Some of you will know inner peace. Some of you will be plagued by inner turmoil. Some of you will truly give of yourselves to those around you, and some of you will be consumed with self. This unevenness is part of our earthly voyage. What is intriguing is that looking at you, no one can say who will do what.

When I graduated from college, if the speaker had announced that one of us sitting there would be elected to the United States Senate at the age of 37 and be diagnosed with cancer at the age of 42, I would have been absolutely and totally certain that neither event would happen to me. And yet, both did.

And at your reunions, similar tales of unlikelihood will be told. Yet it is the very unlikelihood that cries out for stabilizing forces. For handles to grab on to. Well, they exist as well. The same old dull bromides you've heard about forever. Hard work. Family. Community. Love of others. Love of God's earth. I will not preach these values to you, but they are there. Just don't be surprised when eventually you feel the same way.

Someday your life will end. Don't fear your mortality, because it is this very mortality that gives meaning and depth and poignancy to all the days that will be granted to you.

My second message is less personal and more collective. No one is immune from the larger events of his or her time. The Depression. World War II. Civil Rights. Vietnam. The spring of 1989 in China. These events intrude upon our lives and [change] our directions. In my time it was the Kennedy call to public service in the



A shoe-in for this year's "graduate most likely to get her picture in Technology Review": Karen Lewis, '89, daughter of senior editor Susan Lewis.



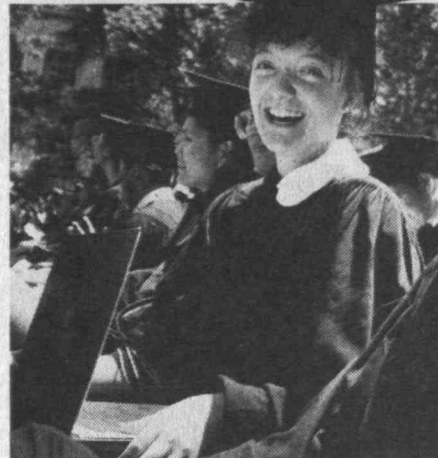
Photo-opportunists abounded.



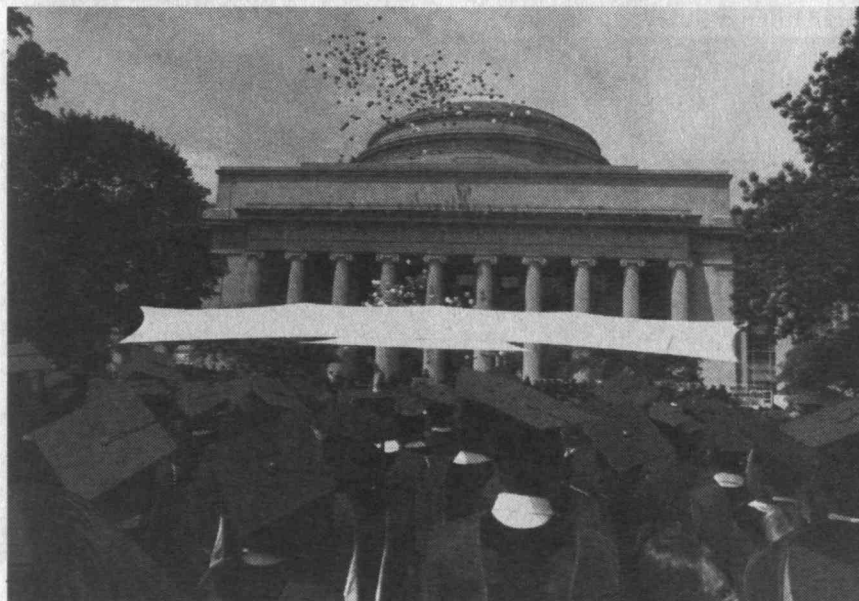
A time when the paths of friends diverge.

Third World. Had there been no Peace Corps, my life would have been radically different. Recent times suggest the onslaught of AIDS, the ignoble effects of the Islamic revolution, and the financial risk of mega-banks and debtor nations locked into a true fatal attraction. But I believe the dominant factor in your lives on a collective scale will be economic.

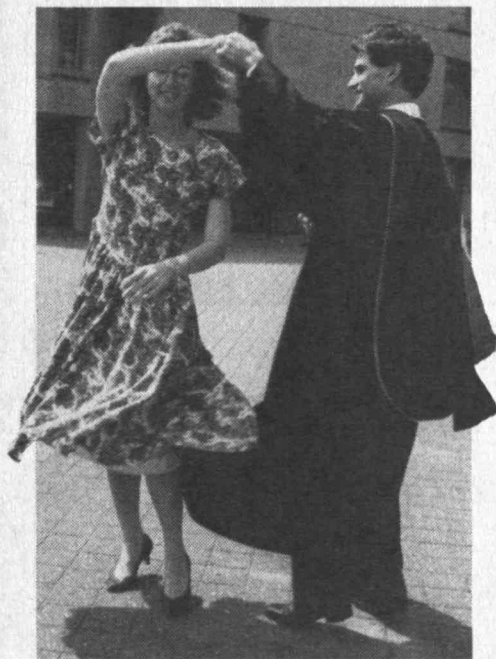
My father's generation gave to my generation a land of wealth and purpose and world economic dominance. My generation has enjoyed this wonderful power: influence abroad, comfort at home, a BMW in every garage, a weekend snort of cocaine by the pool. America's best and brightest flocking to Wall Street to follow



Corinne Wayshak, '89, preserved her graduate's-eye-view of the ceremony with a video camera on her mortarboard.



The hundreds of colorful balloons left no doubt that this was a celebration.



The post-ceremony music and mood were right for kicking up heels.

the gods of Ivan Boesky and Michael Milken. Money. Staggering wealth. Five hundred million dollars in one year. And best of all, there is none of the grubbiness of having to manufacture things, or drill wells, or lay down pipes, or install train tracks. This new wealth comes from sitting in a wonderful office and playing with numbers. The magic words are arbitrage, hostile takeover, leveraged buyout, sale of assets. You would have to be truly stupid to think of inventing something or designing something or creating something. It's all in the numbers.

But there are other numbers: Forty years of increased consumption, falling savings rates, lagging productivity statistics, high

cost of capital. But most of all . . . debt. Crushing debt. In the 1980s we have gone from being the world's largest creditor nation to the worst debtor nation the world has ever known.

America is on the verge of economic decline. We are now in an undeclared, unfelt, and unrecognized battle for our future standard of living. Are we fighting? Yes, we are . . . [but] we are fighting the wrong war. We still pour our resources into the Cold War [as if] the enemy is still the Russian bear. Ladies and gentlemen, the Cold War between the United States and the Soviet Union is over. Not because of anyone there or here being kinder or gentler, but because of economic reality. These two

aging boxers, with flabby midribs, are losing their economic muscle. Quite simply, they can't afford the Cold War. Harsh economic reality created Mikhail Gorbachev, not an accident of history.

I'm not calling for an abdication of our defense responsibilities. They remain. I am calling for recognition of the brave new world that exists. It is time to deal with the other war—the war with Japan and Germany and Taiwan and Switzerland and Korea and France, who sell to us and then take away our patrimony in return. Can we turn our attention away from the Kremlin and face our new adversaries? . . . I think we're ready for that change, but the harder part is taking on our friends.



Emily V. Wade, '45, then-president of the Association of MIT Alumni and Alumnae, led the procession.



Age and tradition: red-jacketed members of the 50th Reunion Class in the vanguard of the procession. (Left to right) Peter M. Bernays, William C. Brewster, William K. Cutten, and Charles Wang.



Proud new physicists Eric Kronenberg, PhD'89, and Steinar Hoibraten, PhD'89



Youth and innovation: a beach ball passed from hand to hand through much of the ceremony.

We in America have lost our edge. When we should be producing, we are consuming. We have horizons measured in quarterly reports, not 10-year plans. We produce with a casualness when the market demands precision. "Whistle while you work" has given way to "take this job and shove it."

The war that I talk about is not one of tanks or planes. It is a war of discipline, of purpose, of will, of determination, of hard work, of sacrifice, of attitude, and above all, education. At the core, it is essentially a war of culture. We have endured our tradition of anti-intellectualism long enough. Let us be done with it. Let us celebrate intellect. Let us honor learn-

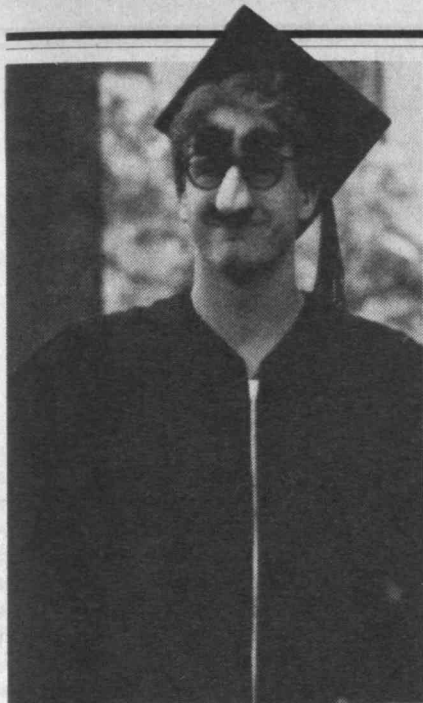
ing. Let us pay homage to the keen mind. We need to see, and to see clearly, what our nation's worries are in the 1990s and beyond. There is no need for Rambo or Conan the Barbarian or Dirty Harry. They are useless in this war.

Our only weapons in this war of your lifetime are the weapons of the mind. In this country we consider those weapons to be curious at best. Unless we change this part of our culture, we will endure a steady decline in the American standard of living in a nation more and more owned by foreign interests.

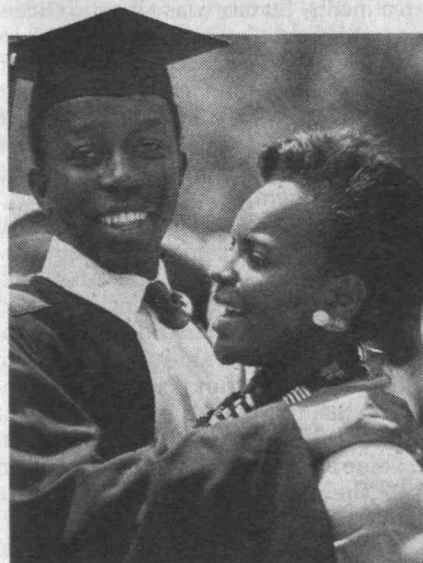
We have not served you well. We have squandered a good part of our collective patrimony. The graduates of MIT, perhaps

more than those of any other school in America, will be called upon to restore that patrimony. You must become leaders in this cultural realignment.

Let me close with a story. There was a fellow from Massachusetts who went to the Grand Canyon. He was looking out at the abyss, 5,000 feet straight down, and was so awed by it that he tripped. Over he went. Fortunately, there was a tree growing about 30 feet below the rim: he grabbed it and was hanging there. Finally, in desperation, he cried out, "Is there anybody up there?" After much silence, a voice said, "I am here, I am the Lord." The man said, "Thank God you're there, God. Could you help me?" The



Graduating despite low Marx.



Commencement is twice as satisfying when shared.

Lord said, "Well, I would be inclined to help you if you have faith in me. Do you have faith in me?" The fellow said, "Of course I have faith in you, but can you hurry up, God, my fingers are slipping." God said, "All right, I will help you. To demonstrate your faith, let go." The man thought for a moment and cried out, "Is there anybody else up there?"

In this new war, in a very real sense, you are what's up there. You are [among] the best and the brightest. It can be a terrible burden if you let it be, but it is the great challenge of your time. And being a warrior in that challenge should be wondrous. I wish you Godspeed for your sake, for my sake, and for my children's sake. ■



Forge a Future Based Not on Power, But on Partnership

By Paul Gray, '54

As you leave here today, you will embark on paths as varied as they are unpredictable, but one thing you hold in common: an understanding and appreciation of the nature of science—its workings, its beauty, its value.

I was going to talk to you this morning about the clouded state of science in this country—as illustrated by the confusion and doubt surrounding the debate over cold fusion and the suspicion underlying congressional inquiries into allegations of academic fraud. I was going to say that much of the confusion and the skepticism is reinforced by the lack of public understanding of science—what it is, how it works, what it's good for. And I was going to ask you to do all you can to help increase the public understanding and appreciation of science and technology—because so much of the world's welfare depends on the fields that you have studied and the work you will do.

These are important matters. They do bear on the quality of our lives. And I hope you do accept that charge.

But the horror of the weekend's events in China remind me once again—as they remind us all—that the future of the world depends fundamentally on people having a voice, having sovereignty over their lives. Education is a key to that, to be sure—and it is with good reason that the leaders of the movement for democracy in that country are the students.

The massacre in Tiananmen Square—in the shadow of Mao's tomb, in front of the Great Hall of the People, and in the presence of a statue of liberty—shows how easily and dreadfully the spark of freedom can be crushed by those who hold power and are so afraid of losing it. So afraid they cannot hear the voices of those who ask simply to take part in their own governance . . . so afraid they cannot hear the

voices of those who counsel moderation and reason, discussion and debate . . . so afraid they cannot hear the voices of the workers, the parents, the children who flocked to the square with hope and a dream . . . so afraid they cannot hear the voices of the soldiers in the People's [Liberation] Army who ask "why?" . . . so afraid they could not—would not—hear their own consciences as the gunfire echoed through the night and the tanks rolled in—and over—their own people. People who just wanted a voice. People who wanted democracy.

The spark of freedom in Beijing may be crushed, but only momentarily. No nation can long ignore the calls of its students and their teachers for freedom. No nation can long suppress the call to freedom which comes from those on whom its future so critically depends. I have confidence that the students will keep the flame.

If there is one thing that symbolizes the value of the university, it is the idea of the forum—a place where any idea can be discussed, where truth is not an ideology, where reasoned debate and impassioned discourse are cherished, where respect for different points of view, different cultures, different peoples is the bedrock, the place where we begin. That was part of what the students were asking for. And that respect, that trust in a system that depends on individual voices' being heard, is the surest way to build the common good.

Now, as you move from these halls onto the world's stage, I have many hopes for you. But I would ask of you one thing above all, that you hold to the values of democracy: the freedom, indeed the obligation, to talk and to listen and to forge a future based not on the power of one group of people over another, but a future based on a partnership among peoples, among nations, people who respect each other enough to trust each other.

You have the ability—I know you do—and I trust that you have the will. Our future is in your hands.

Good luck and Godspeed. ■

The above is the charge to the graduates delivered by President Paul E. Gray, '54, at Commencement Exercises on June 5.



Endowing Unpopular Causes with Credibility and Cash

By Margery Resnick

Stanley McCormick Hall, MIT's first dormitory for women, marked its 25th anniversary on Friday, April 28, with a celebration honoring the woman who made the dorm possible along with reminiscences from representative residents over the years. A tribute to Katharine Dexter McCormick, '04, was provided by Margery Resnick, an associate professor in foreign languages and literatures at MIT and a former faculty resident at McCormick Hall. Here is a condensed version of Resnick's remarks "about a woman whose intelligence, humor, grace, and independence of spirit allowed her to leave a mark on the world while never ignoring the painful vicissitudes and responsibilities of her private life."

Katharine Dexter McCormick was born in 1875 to a wealthy and distinguished family. Her grandfather, Samuel Dexter, was a U.S. senator, secretary of war under John Adams, and secretary of the treasury under Adams and later Jefferson. Katharine's grandfather, Samuel, after graduating from Harvard in 1812, moved to Michigan where he founded the town of Dexter, near Ann Arbor. He served as chief justice of the county court, published a small newspaper, and helped found the University of Michigan. Her father, Wirt Dexter, was a lawyer and one of the most eminent jurists of his time.

After her husband's death at age 59, Josephine Moore Dexter moved with her daughter to Boston. Katharine was ready for college—a path relatively few women chose at that time, since they did not have the right to vote or to enter any of the professions except nursing and teaching in the lower schools. If wealthy, a woman could be an ornament to society; otherwise, her function was to raise children and perform the rituals of domestic life. But four years after her debut, Katharine entered MIT.

What made her go against tradition? Her freshman essays provide some key to her motivation. In an assignment entitled "A Brief Account of My Life" she wrote: "I shall never cease to be grateful to the 'romance of destiny' that enabled me to be born . . . in what was then . . . the west of this country. The life there is . . . bleak

and uncultured in many ways, but its strength and force, its lack of prejudice, its heartiness, are wonderfully stimulating to the individual and force an invigorating commencement to . . . life. The influence that came from my surroundings . . . [was] the skeleton about which my life has grown."

Katharine Dexter completed the three years required as a special student and then four undergraduate years to earn a degree in biology in 1904—a year in which 44 of the 1200 students at MIT were female. While her fellow students may have seen their women colleagues as mere curiosities, Katharine used MIT to acquire skills and knowledge in biology that altered the course of her life and that of women around the world.

Shortly after her graduation, Katharine married Stanley R. McCormick, youngest son of Cyrus McCormick, inventor of the reaper and founder of what was to become the International Harvester Co. At the time of their wedding, the future looked bright for the young couple. Stanley had gradu-

ated from Princeton in 1895 with highest academic honors and was now comptroller for the McCormick Reaper Co. Both Katharine and Stanley shared an active interest in athletics, art, music, and travel.

Two years after their wedding Stanley became acutely mentally ill. Until his death in 1947, Katharine was alone but never free of the tragic circumstances of her married life. After a series of futile treatments, Stanley was taken to Rivenrock, his estate in Santa Barbara, where Katharine directed his constant care until his death at age 73. Her devotion to him was unlimited—she arranged for musicians to play at his dinners, made sure that the beautiful gardens were cared for, and visited frequently.

The possibility of finding a cure for schizophrenia was a priority for Katharine during Stanley's entire life. After psychoanalysts failed to help him, she turned to Roy Hoskins, a Harvard endocrinologist who had been studying the role of adrenal cortex malfunction in schizophrenia. Katharine thought his hypothesis that schizophrenia was a matter of biochemistry bore investigation. Toward that end, in 1927, she established the Neuroendocrine Research Foundation (part of the Worcester Foundation) to support Hoskins' work and that of others looking into the biochemical aspects of mental illness.

One can only imagine the emotional solitude as well as the pragmatic burdens of such a marriage. When it became apparent that Stanley could not function with responsibility, Katharine fought and won an arduous and bitter battle with his family for control of his assets.

While still engaged in legal battles and personal trials, Katharine found focus for her life in the crusade for women's rights.

She was a charter member of the College Equal Suffrage League of Massachusetts, founded in 1909, a group of some 15 women who actively campaigned for the vote with rallies and demonstrations. She saw her notices torn down by male students at her alma mater, but she never succumbed to defeat. For example,





Katharine Dexter McCormick, '04, at the dedication of the west wing of McCormick Hall.

when she and a group of friends were forbidden to speak on the beach at Nantasket, she went into the water with a megaphone and delivered her message from the surf.

One of a small group of women forming the radical vanguard fighting for women's rights, Katharine was active both nationally and as an officer of the International Women's Suffrage Alliance. During World War I, she served as chairwoman of the War Service Department of the National American Woman Suffrage Association (NAWSA), and in 1917 was appointed to the National Defense Women's Committee. In this capacity, she publicly refuted charges by

their opponents that suffragists were "slackers, unpatriotic, pro-German, and concerned only in getting the franchise for themselves." Certainly the great contributions made by women during the war strengthened the suffragists' arguments. By August 26, 1920, enough states had ratified the 19th Amendment, and the secre-

tary of state formally proclaimed it in effect.

Katharine Dexter McCormick's work also provided continuity between the suffrage and birth control movements. Carrie Chapman Catt, leader of NAWSA, was indifferent to Margaret Sanger's Planned Parenthood Foundation (PPF) and its crusade for

contraception. Sanger, for her part, had contempt for the suffragists—feeling that the vote was a superficial reform as long as women lacked control over their reproductive destiny. But Katharine believed that both were essential.

She met Margaret Sanger in 1917, when the latter had come to Boston to help raise

"My Preparation for the MIT"

By Katharine Dexter, '04

[A freshman essay dated October 4, 1899, in which her droll irony was met with pedantic disapprobation.]

The Massachusetts Institute of Technology! How much have I heard about it! I heard how scientific it was in all ways even to proclaiming the doctrine of Evolution by permitting the survival of only the fittest of its students. Above all I had heard of its almost insurmountable difficulties. It was described to me how these confronted the pale student on entering and how they pursued him as he grew paler and yet more pale through the death march of four years. It was said that, should he live to finish his course and behold his degree, he stood a physical and mental wreck on the threshold of the Rogers Building. . . .

Why, I asked myself, does not some one enter this Institute of Technology so fully prepared that his work becomes a mere pastime to him, that he can enjoy to the full the social and athletic advantages—to say nothing of the Lowell lecture course—so that he issue from the ordeal stronger in body and more cheerful in mind than ever before.

Why, I again asked myself, should I not be the one to accomplish this; to demonstrate how irresistible is the combination of health and an Institute education? I resolved to try.

I entered the nearest college and quitted it only after I had obtained its degree. Not satisfied with that I undertook some post-graduate work [for] two years at a neighboring university. There, as it occurred to me that the modern

languages would be essential to parts of the curriculum for which I was striving to prepare myself, I went to France to study. While there I mastered the French language and amused myself with various chemical researches conducted under the supervision of the great professors there available.

I then passed to Germany to one of the foremost universities. I studied thoroughly the German language, at the same time pursuing courses in the ancient languages, such as Greek, Hebrew, and Sanscrit [sic], in order to be the better prepared for the study of English at the Institute. Finally, I returned to this country and cautiously entered the Massachusetts Institute of Technology as a special student.

To give an example of what I there encountered I will say

that during my first week I was requested, in a course on English composition, to write a theme on the subject "My preparation to enter the Institute." In writing this I was asked to confine myself to three pages of theme paper! My life, my work, my travels, the endless complications of which served merely as a preparation to the Institute, all this I was requested to relate on three pages of theme paper! The impossibility of the demand struck me at once and I remembered all that I had been told. I do not now doubt but that I shall fail to succeed in my undertaking, all my previous work seems to have been done in vain, and I, myself, can only despair.

The English instructor's comment on Katharine's paper: "Correct in form; margins admirable; punctuation careful. You quite misunderstood the subject." □



The highlights of the McCormick 25th Anniversary were the address by Margery Resnick (above) and the re-naming of the Brown Living Room for longtime house manager and mentor Norma Mele (below).



money for the defense of Van Kech Allison, a student who had been sentenced to three years in jail for distributing Emma Goldman's essay "Why and How the Poor Should Not Have Many Children" to women factory workers. During the 1920s Katharine was one of the European travellers who helped keep Sanger's clinical research bureau in operation by smuggling diaphragms into the United States. Thus began a lifelong collaboration between the two women.

Sanger had told Katharine about Gregory Pincus, a physician and researcher at the Worcester Foundation who had been working for years on a hormonal contraceptive with small grants from PPF. Katharine went to see him. After studying thoroughly the existing research on the use of synthetic hormones for birth control, she came to the conclusion that Pincus was on the right track. Her discerning judgment in considering which research efforts to support owed much to her analytical training and background in biology.

From that time until her death, Katharine contributed \$180,000 per year to the support of research in hormonal contraception. At a time when large foundations were reluctant to touch the subject, and the attitude of government agencies was hands-off for political reasons, Katharine's unflinching concern with women's control of their own destinies made possible the rapid development of the birth control pill. To a degree never before envisioned, it set men and women free sexually. It liberated women to study and work without interruption by an unintended pregnancy. It provided the first real hope that the world's runaway population growth could be controlled. Although the first successful use of synthetic steroids as oral contraceptives was announced in 1956, Katharine continued her annual funding and left \$2 million in her will for the continued research and refinement of birth control methods.

In 1960, she was wooed as a donor by Radcliffe College. At age 75 she marched into the office of the Dean of the College and announced that she would give the funding provided Radcliffe used the money to establish a birth control clinic.

Since dispensing birth control to unmarried women was illegal in Massachusetts well into the 60s, Radcliffe had to reject this offer of support.

Fortunately, her offer of help to MIT was easier to accept. On June 15, 1960, Katharine McCormick wrote to Margaret Sanger, "I am particularly happy to be able to provide a dormitory on the Tech campus for women students there. This has been my ambition for many years but it had to await the oral contraceptive for birth control." With that priority met, Katharine could turn her full attention to the construction of MIT's first women's residence. At the time, enrollment of women undergraduates was essentially what it had been during Katharine's student days more than 50 years before. The single factor that determined this low enrollment was lack of housing. During the next three years, Katharine worked closely with the architect and interior designer of the new building on the most minute details. Many of her personal possessions were placed in the dormitory and a great

deal of her personality is reflected in the building.

On October 7, 1963, the west wing of McCormick Hall was dedicated. The second wing was completed and dedicated in March of 1968, but Katharine did not live to see it. She died December 28, 1967, at the age of 92. In her will she had written, "Since my graduation in 1904, I have wished to express my gratitude to the Institute for its advanced policy of scientific education for women. This policy gave me the opportunity to obtain the scientific training which has been of inestimable value to me throughout my life."

Going back to the archives has been a revealing journey. It is clear that the principle of self-realization for women is an integral thread in the fabric of her 92 years. In the personal sphere, her battle for the right, as his spouse, to provide for her husband the best and most humane treatment available while constantly investigating cures; in the political, her battle for the right of women to vote; in the educational, by acquiring herself and making possible for other women a scientific education; and most important, her commitment to women's sovereignty in the determination of whether or not to bear children—all are aspects of an amazingly coherent world view. Her legacy is one of the confidence and will to bring about further progress for women.

I remember that the invitations to our annual Katharine Dexter McCormick Tea always read, somewhat jokingly, "hats required, gloves optional." Students would come in all sorts of fancy hats, and all kinds of functional gloves—baseball, cooking, rubber gloves, etc. Thinking through Katharine's life, these were fitting symbols. She always wore hats—representing her class and upbringing, poise and decorum—but she also wore, at least metaphorically, all sorts of gloves that allowed her to work productively and consistently in causes affecting women's lives. □

Note: Much of the historical information in this speech was found in the Institute Archives & Special Collections of the MIT Libraries.



ALUM. NEWS

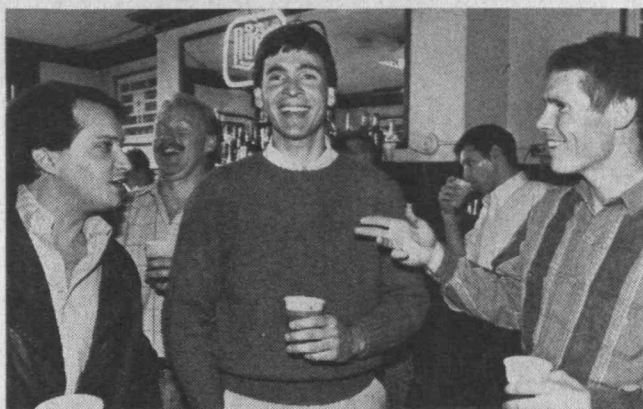
FIJI Marks Centennial

The 100th anniversary of the chartering of the Iota Mu chapter of Phi Gamma Delta, FIJI for short, drew 274 brothers and guests to a weekend celebration in April.

The FIJI chapter at MIT was established on March 30, 1889, as the third fraternity on campus. After a formal ceremony, the eight new initiates held a banquet at the Boston Tavern, where they enjoyed a punch "concocted by those mixmasters from the Department of Chemistry," according to an eyewitness account. Several of those early members went on to distinguished careers in academia and business, including one, Elisha Lee, '92, who became executive vice-president of the Pennsylvania Railroad.

No less distinguished was this year's assemblage, which included Richard Schmalensee, '65, professor in the MIT School of Management and member of the President's Council of Economic Advisors, and Patrick McGovern, '59, chairman and CEO of International Data Group.

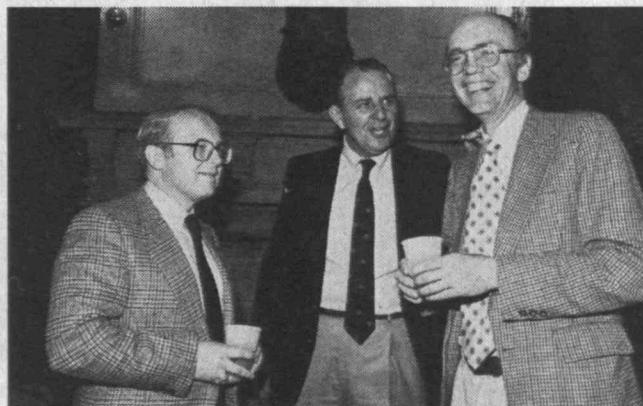
Morell Marean, '30, was the oldest FIJI brother at the reunion, and Alf Bjercke, '44, from Norway, came the greatest distance. It came to light that due to an unusual combination of circumstances, Bjercke was never formally initiated into the chapter. So a group of brothers got together to rectify the situation, making Alf the newest member of Phi Gamma Delta.



Seems like home to be back in the FIJI fraternity house for John Simmons, '79, Greg Blahut, '84, and Owen Fordham, '82.



Steve Meyers, '76, John Sitarski, '74, Bob Mohr, '72, and Edward Schmidt, '72, at the FIJI anniversary tournament.



FIJI camaraderie is still strong almost 30 years later for Don Weaver, '60, Don de Reynier, '60, and Tom Hastings, '61.

The weekend was a rare opportunity to mix with old friends from many different classes and included a golf tournament, a performance at the Omni Theater at the Museum of Science, a brunch cruise around Boston Harbor, and class dinners at various restaurants around the city. The highlight of the weekend was the Marshall B. ("Jack") Dalton banquet, named to honor Jack Dalton, '15, who played a critical role in the success of the chapter early in the century. □

WILLIAM S. KAISER, '77, is a general partner in a venture capital company in Boston.

The '60s Still Live at ESG

It's April 22, 1989, and this is the thousandth time I've pressed the elevator button for the sixth floor of Building 24. But it's the first time with my wife and child, and only the fifth time in the last 10 years. We're on our way to the 20th anniversary reunion of the Experimental Studies Group. I wonder about ESG. Does it look the same? Are the students concerned about the same things? Will I still recognize people I haven't seen for 10 years; will they recognize me?

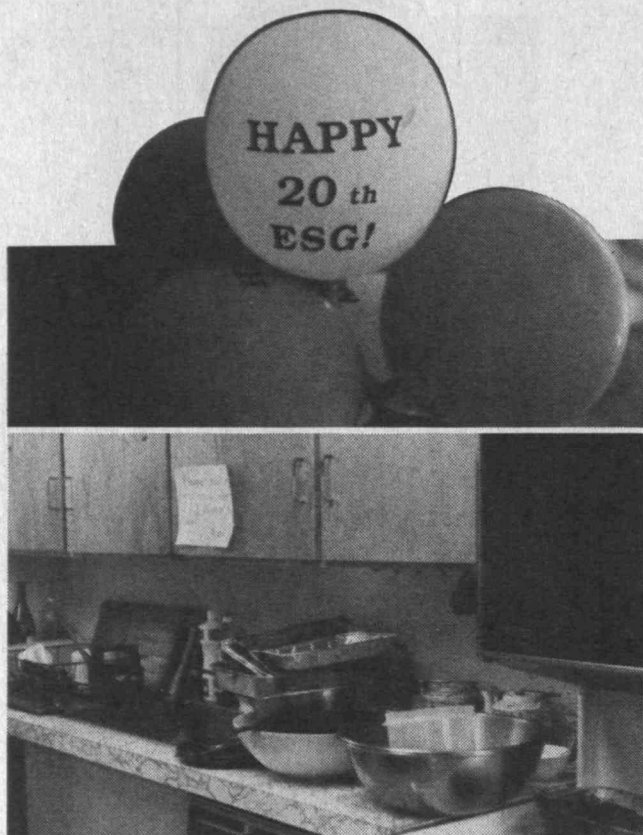
ESG started in 1968 in the midst of the Vietnam protests and student strikes. Twenty years later it occupies the same space and holds the same intention, to allow freshmen and sophomores the option of designing their

own schedules and curriculum in an environment that is truly collegial, almost family.

ESG now has its fourth director, Vernon Ingram, its second administrative assistant, Holly Sweet, and is now a "regular" part of the MIT curriculum. In 1985, it was awarded the Irwin Sizer Award for its contribution to education at MIT. There are about 800 alumni/ae of the program now, of whom 65 came to the reunion weekend.

Reunion activities started with the traditional Friday lunch. Paul Lieberman, '76, gave a talk and slide show about his current life style on the "Skinnerian" commune, Twin Oaks, in Louisa, Virginia. Twin Oaks hasn't changed much in the last 10 to 15 years, and the only change in Paul is that he now runs a successful software consulting business from the mainly agricultural and hammock-making community.

Along with Herb Lin and Gregory Moore, both Class of '73, I spoke to current ESGers at the seminar on "Leadership and Teamwork in the Workplace." I hardly recall hearing the word "leadership" used during my five years at ESG as a student and physics instructor. Now that



ESG's Friday lunch dishes haven't changed a bit.

I am an engineering manager, I find it encouraging that students are inquiring into these issues.

Joel Gendler, '82, led a bubble demonstration that he often performs for children at the Boston Science Museum. The children, including my seven-month-old, were fascinated by the shapes and colors. The adults were fascinated by the physics: Why is it that you can arrange six similar-sized bubbles around a central one, but not seven?

What's the source of the "steam" that is often seen inside a bubble? In the end the children won out, and everyone was making huge and interesting bubbles.

Aubrey Jaffer, '77, Harry Bochner, '76, and Arne Langsetmo, '76, led a music seminar. Arne entertained us with his family of dulcimers, several of which he built. Everyone got involved with the discussion of tuning: well-tempered—where you can change keys and have it

sound right—or natural-tempered—where the harmonics are richer, but if you change keys, it sounds wrong.

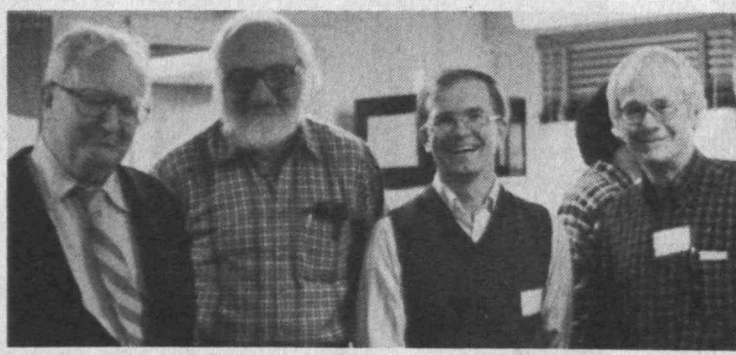
Then the large seminar room filled for an event billed as a "group discussion of ESG then and now." It sounded just like the many discussions of "what's wrong with freshmen now?" and "what should freshmen be required to do?" that I remember from my years here. The general consensus was that although there are more foreign students and fewer hippies in the ESG classes, and there is less time spent by freshmen on subjects other than general Institute requirements, the educational issues haven't changed and ESG's main asset is still its intellectual-community atmosphere.

All in all, the rooms are the same as they once were, with the addition of Athena workstations in the lab and some new sofas. Everyone's clothes, hair, even weight, are much as they were in our student days. About one in three is married—most with children—and 90 percent of us work in software engineering. □

PETER FIEKOWSKY, '77, is a consultant in image processing in Santa Clara, Calif.



(L to R) Paul Lieberman, '76, through a giant Fresnel lens. Herb Lin, '73. ESG's



four directors: George Valley, '35 (1969-74), Robert Halfman, '44 (1974-84), Kim

Vandiver, PhD '75 (1984-89), and new director Vernon Ingram. Holly Sweet, ESG

associate director and "mother hen" since 1977, with Doug Milliken, '77.



Concert Band: 40 Years Old, But Still New

Could this be the time when the Kresge roof actually lifts off the three points where it is connected to the ground?" asked President Gray on the occasion of the Concert Band's 40th anniversary concert. That the band did not quite succeed in blowing the roof off is a comment on the auditorium's construction, not the enthusiasm and numbers of MIT's oldest new-music ensemble.

The Concert Band's first public performance was conducted by an energetic young bandleader named John Corley on May 5, 1949, at the Hatch Shell. This year's annual spring concert was conducted 40 years and one day later by the still-energetic Corley.

The more recent event featured the largest (and loudest) incarnation of the concert band in history: Nearly 100 woodwind, brass, and percussion players packed the stage for the opener and finale. Fifty-six of the players were regular members of this year's band; 17 were Boston-area alumni/ae who had been attending regular rehearsals for several weeks; and the remainder were alumni/ae who had flown in just for the day—the morning rehearsal and the evening concert.

Front and center in the flute section was Jim Burkhardt, '51, who founded the band by recruiting surplus woodwind players from the 1948 MIT Symphony auditions. On the band's behalf, Klaus Liepman of the Music Department put a call in to Corley, then a trumpeter with the Boston Symphony. Intrigued by



what he saw at the Burkhardt-led rehearsal, Corley took the assignment and spent the next five years hammering out the ensemble's collective mission: to play challenging music written expressly for band.

That means no high school marching band pieces and no musical comedy or symphonic transcriptions. After all, says Corley, "MIT already has groups that play musical comedy and symphonies very well." So he applies the band's distinctive warm sound and virtuosity to a broad range of unclassifiable twentieth century music, ranging from Holst suites to jazzy Gershwin-like concertos to sometimes painfully atonal experimental works.

At the band's request, Corley chose his favorite pieces for the anniversary concert. His greatest-hits list included two works by alumni: a dark, complex suite by John Bovicchi, '44, now a respected composer at Berkeley College of Music, and the wonderfully upbeat "Prelude and Happy Dance," by Andrew Kazdin, SM, '63, now an independent classical music producer.

Also featured was "Essay for Band," composed in 1959 by William Maloof and dedicated to Corley and the Concert Band. One of the most popular pieces in the band repertoire, it has also been performed more than 100 times by other groups. An Oxford University Press pub-

lication project begun in 1986 may well lead to similar exposure for the 47 pieces commissioned by the band over the years.

Future commissions and special projects will be supported by a newly endowed fund, which was announced at the anniversary concert. Neal Hoyer, '87, now in graduate school at Washington University in St. Louis, proposed the idea to fellow sax player Ed Ajhar, '86, a graduate student at MIT. Ajhar completed the necessary paperwork for the John Corley Concert Band Fund, named "not in memory of John [but to honor him], because we hope he'll keep going for a long time." (Alumni/ae have the option of designating their MIT contributions for the fund.)

"Many MIT undergraduates chose to stay here for graduate school because of John Corley and the band," says flute section leader Arlene Lanciani, '88, who is one who made such a choice. During her term as band president in 1986, the ensemble became a year-round activity; it now meets one evening per week during the summer to rehearse lighter music for concerts at MIT and Faneuil Hall.

At one break in the anniversary program, Corley asked alumni/ae onstage and in the audience to introduce themselves. He remembered each one. "George St. George, '76, wrote a piece called 'The

The picture of John Corley is from 1965, but a recent photo looks much the same.

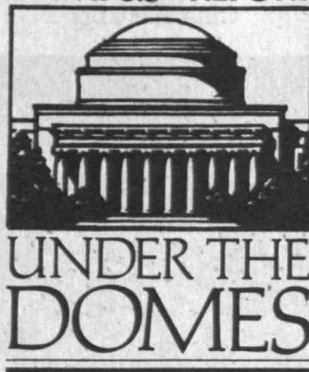
Dragonslayer,' which we performed . . . Mike Moritz, '73, played piano for the Stravinsky . . . Jim Burkhardt not only founded the band but conducted it for three weeks before he interviewed me . . . Bill Grossman, '69, took a night off from conducting 'Cats' on Broadway to play percussion with us tonight." Corley even identified one former student from Brookline High School, where he taught for 17 years. Then it was back to the music with renewed intensity.

"It was so remarkable to cue a man from 1953, and see that face again and know he'd be there," mused Corley after the concert. It was equally remarkable for the returning grads to pick up their horns and look up to see John Corley. □

DIANA BEN-AARON, '85, who played flute in the MIT Concert Band, was able to restrain her George Plimpton complex and sit happily in the audience for this event.

Tutoring Plus To Celebrate

And speaking of anniversaries and reunions—Tutoring Plus, a Cambridge neighborhood organization that involved many MIT students working with local school children, will hold a 25th anniversary celebration on October 11. Since a fire several years ago destroyed the group's historical records, it will be difficult to invite former volunteers to the party. Anyone who would like to have his or her name added to the Tutoring Plus mailing list should contact Adam Bird, SIAR, Inc., 22 Putnam Ave., Cambridge, MA 02139, (617)354-2320. □



Search for President Heats Up

Channels have been opened up to funnel the views of MIT alumni and alumnae to the Corporation's Committee on the Presidency, chaired by Carl Mueller, '41. (Mueller is the retired vice-chairman of Banker's Trust Co., New York, and also chaired the committee that nominated Paul E. Gray, '54, for president.)

As outlined in a memo to Mueller by Alumni/ae Association Executive Vice-President William J. Hecht, '61, the directors and officers of the Association are being asked to solicit the input of Institute grads and relay this information to Hecht, Emily V. Wade, '45, immediate past president of the Association,

or Harris Weinstein, '56, current president, for transmission to the presidential search committee.

Alumni/ae are being urged to consider three issues: one, the agenda for MIT in the 1990s and beyond; two, the characteristics desirable in a new president; and three, the names of potential candidates.

The officers of MIT clubs will be asking for input from their members on those three issues, and the replies will go to the search committee through the Association Board of Directors.

Members of the search committee who will be serving with Mueller include:

John K. Castle, '63, chairman and chief executive officer, Castle Harlan, Inc., New York.

Edward E. David, Jr., '47, president, EED, Inc., Bedminster, N.J.

Joseph G. Gavin, Jr., '41, retired president and chief operating officer, Grumman Corp., Bethpage, N.Y.

Robert A. Muh, '59, investment banker, San Francisco.

DeWayne J. Peterson, Jr., '55, executive vice-president, Merrill Lynch & Co., New York.

Mitchell W. Spellman, dean for medical services and professor of surgery, Harvard Medical School.

Raymond J. Stata, '57, chairman and president, Analog Devices, Inc., Norwood, Mass.

Mary Frances Wagley, '47, retired educator, Baltimore.

Presidents Emeriti Howard W. Johnson (H), Julius A. Stratton, '23, and Jerome B. Wiesner (H), will serve as consultants to the committee. Walter L. Milne (H), assistant to the chairman of the Corporation and to the president, will serve as the search committee staff.

Institute Professor Robert M. Solow of economics will chair a Faculty Advisory Committee to the Corporation on the presidential search. Associate chair of that committee is Professor Philip A. Sharp of biology. □

[Note: (H) signifies honorary membership in the Alumni/ae Association.]

Branching Out

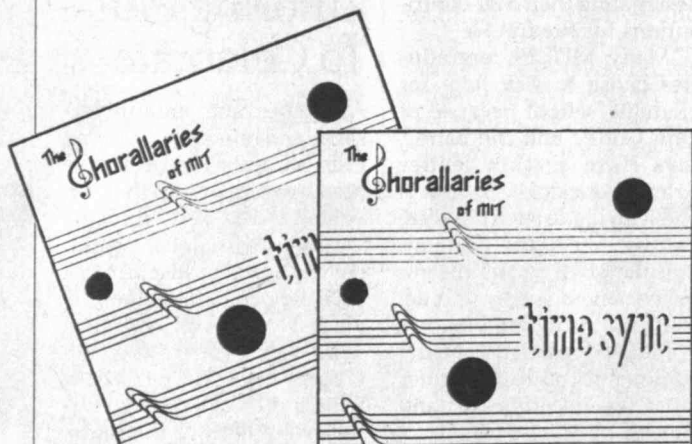
■ The Technology and Policy Program (TPP), now in its 13th year of educating poten-

tial leaders on the important technological issues confronting society, has expanded its focus by adding a curriculum track emphasizing the social sciences and policy studies.

Initially, a small number of students will be admitted to the new program through the TPP faculty and, in a separate admission process, the Department of Political Science. Professor and TPP Chairman Richard de Neuvville, '60, said the new curriculum is appropriate for students who wish to emphasize political, economic, and organizational aspects of technology and policy in their coursework and thesis. The distribution of subjects is virtually the same, he said, with the essential difference being one of emphasizing policy aspects more than technological considerations. But, he continued, "the program will continue to insist on dual competency in both technology and policy."

TPP won the Sizer Prize last year for the most significant contribution to MIT education, and currently enrolls about 70 master's degree candidates.

■ The Department of Electrical Engineering and Computer Science has recently lifted its policy of "accepting no transfers." The only department ever to have such a restriction, EECS implemented the policy five years ago in order to cope with a ballooning enrollment for which it was not equipped. Now that the pressure has lessened, transfer students will be considered again, although not actively sought. □



The Chorallaries, an a capella mixed singing group founded at MIT in 1977, has released its fourth album, Time Sync. The group's voices have

carried them from the State Department in Washington, D.C., across the country to Caltech, and back home to local hospitals and rest homes.

1988-89 Sports— The Year of Ever

Extraordinary.
Unique.
Unparalleled.

Each of the above adjectives has been used to describe the success of the MIT athletic program during 1988-89. From the first NCAA Division III football game in September through 17 wins by the baseball team, 1988-89 was the year of many firsts and bests . . . the year of "ever."

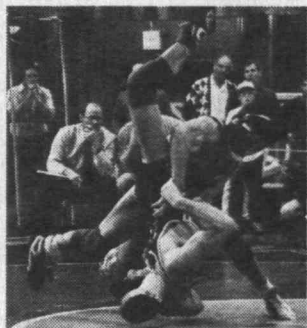
■ September 24, 1989, marked the first ever NCAA football game at MIT.

■ Shane LaHousse, '90, ran for 260 yards in the season-opening game—the most yards ever in a single game by an MIT player and the first MIT player ever to be Eastern College Athletic Conference (ECAC) Player of the Week and New England Football Writers Association Gold Helmet Award Winner. At the end of the season, LaHousse became the first MIT player ever to be named ECFC Player of the Year.

■ Darcy Prather, '91, became the first MIT football player ever to amass 100 tackles in a season, finishing with 117. He broke his own record of 96 set in 1987.

■ The MIT **heavyweight crew** won the Club Division of the Head of the Charles Regatta for the first time ever.

■ Scott Schwartz, '89, became the first wrestler ever to win the MIT New England **Wrestling Classic** three times, and was also the first wrestler ever to twice be named the Outstanding Wrestler of the Tournament.



■ Lisa Arel, '92, became the first female MIT **gymnast** ever to be named ECAC Gymnast of the Week, and later became the first female MIT gymnast ever to win the all-around competition at the New England Division III meet.



■ The **men's ski** team won the Eastern Intercollegiate Ski Association Division II Championship for the first time ever.

■ The **men's basketball** team scored 112 points in a season-ending win over Emerson College for the most points ever scored by an MIT team in a single game. The 51-point margin of victory in the game was also the largest ever by an MIT team.

■ Alec Litowitz, '89, is the first MIT **squash** player ever

to be named a squash All-American.

■ **Swimmer** Yvonne Grierson, '90, became the first MIT athlete ever to win two national titles at one championship (100 butterfly, 100 freestyle). Grierson's performance led MIT to its best ever 16th place team finish nationally.

■ The **indoor track** team's sixth place in the NCAA Division III meet was the Engineers' highest finish ever at the nationals.

■ The 17 wins by the **baseball** team represented the most wins in a single season ever, and also helped the team qualify for the ECAC Division III Tournament for the first time ever.



■ The **outdoor track** team placed third in the Greater Boston Conference championship for its best finish ever in the meet. The team also won the New England Division III meet with the highest point total ever (150), and by the greatest margin ever (81 points). They then went on to tie for a best-ever 5th place in the NCAA Division III Nationals, led by decathlon winner Bill Singhose, '90.



■ Singhose set a new MIT decathlon record of 7,206 points at the Nationals, 512 more than his nearest rival.



■ **Lacrosse** midfielder David Chang, '89, amassed the highest MIT single-season point total ever by pumping in 45 goals and 33 assists for 78 points. Chang also set the career assist record with 81. Teammate Pat Nee, '89, scored on the last shot of his career to total 102 goals over four years. That is the most ever by an MIT player.



■ MIT had four coaches named **regional coaches of the year**. Men's basketball coach Leo Osgood, women's basketball coach Corinne Gulas, ski coach Dave Michael, and track coach Gordon Kelly combined to give MIT its greatest number of Coach of the Year Awards in a single year ever.

■ MIT student athletes have earned **All-American** honors 22 times in 1988-89, with additional honorees likely. Already that is the greatest number of All-Americans in a single year ever at the Institute.—Roger Crosley □

ROGER CROSLEY is the director of sports information at MIT.



■ Football wide receiver Tony Lapes, '90, caught 11 passes against Bentley College to set every MIT single-game, season, and career pass-receiving record ever.

Taking MIT's Case to the West

The Campaign for the future went on the road last spring, with glittering kick-off events in Dallas and Silicon Valley. The guest lists for both events included key volunteers and donors who are setting the pace for campaign efforts in

their areas. Keynote speaker in each case was David Baltimore, '61, Nobel laureate, director of the Whitehead Institute for Biomedical Research, and nationally recognized spokesman for science—particularly AIDS research. President Paul E. Gray, '54,

made the case for MIT on both occasions. The Dallas program included remarks by Cecil H. Green, '23, honorary chairman of the campaign; and Paul Cook, '47, honorary chairman of the Silicon Valley Campaign Committee, spoke there. □

1 Robert Pearson, '63, of Lamalie Associates, and Norma Pearson join President Paul Gray, '54, and Chairman of the Corporation David Saxon, '41.

2 Paul Cook, '47, of Raychem Corp., Marcia Cook, Marilyn Pratt, and Kenneth Ross, '65, of Ross Systems.

3 President Gray, Gerald Burnett, '64, of Teknekron Corp.

4 Judy Swanson, Keynote Speaker David Baltimore, '61, and Robert Swanson, '69, of Genentech.

5 John Freiburger, '45, retired, Irma Grossman, and Irwin Grossman, '52, of Investment Properties.

6 Robert Metcalfe, '68, of 3Com Inc. and chairman of the Silicon Valley Campaign Committee.

7 Reid Weedon, '41, of Arthur D. Little and chairman of the National Campaign Committee, with Daniel F. Flowers, '41, of Differential Corp., Jeanie Flowers, and D. Fort Flowers, Jr., SM '85, also of Differential Corp.

8 Walter Humann, '59, of Hunt Consolidated and chairman of the Dallas Campaign Committee, Bea Humann, Joe Moore, '52, of Bonner & Moore Associates, and Glenna Moore.



9 David Saxon, in the ballroom of the Tower Club in Dallas and in a role that he has filled throughout the Campaign for the future: master of ceremonies for a gala affair





CLASS NOTES

18

There has been a dearth of contacts with classmates since the previous issue. An exception happened this evening (April 27) when I saw **Eli Berman** for a few minutes while he was playing bridge with guests here at North Hill. He has just returned from San Diego where he spent the winter under ideal conditions. He looks good and is enjoying life.

I was a guest today at a special 90th birthday celebration for George Michelson, '19. Following a Saturday service at Temple Kehillath Israel in Brookline, there was a most enjoyable luncheon for about 200 guests. I have enjoyed a close friendship with George for over 60 years. He was best man at my wedding. He has been active in his support of MIT activities. In his professional career, he has pursued the MIT tradition of success. He has given of himself to the Boston community in many ways, particularly as president of the Hebrew Teacher College and many philanthropic activities. Here is a wish for continued good health and more creative civic accomplishments.—**Max Seltzer**, Secretary, 865 Central Ave., Needham, MA 02192; and **Leonard I. Levine**, Assistant Secretary, 546 Washington St., Brookline, MA 02146

20

70th Reunion

A welcome letter from **Moses Pike** says, "This spring marks the 10th anniversary of my retirement from the Maine sardine industry after 42 years! . . . I realize there are not many of us left, but I wanted to let you know that here's one fellow who hasn't left yet and has no immediate plans to do so." Moses lives at 6 Church St., Lubec, Maine. I am sure he would be glad to hear from you. I commend him for his class spirit!

I must admit that my absence from previous class notes is due to lack of any news from classmates. I promise to report anything that comes my way. Hope you have had a good summer.—**Harold Bugbee**, Secretary, 313 Country Club Heights, Woburn, MA 01890

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Peter A. Diamond, professor of economics, has been named as the first holder of the John and Jennie S. MacDonald Professorship, effective January 1, 1989. The professorship was established by a gift from the late **Edmund J. MacDonald** in memory of his parents. Professor Diamond, who was head of the Department of Economics in 1985-86, is an authority on taxation, social security, and uncertainty theory. He is beginning to work in macroeconomics.

Four deaths are being reported this month. **Edson I. Schock** of Kingston, R.I., died on October 21, 1988. He designed more than 200 boats in his spare time including the hermaphrodite brig, the *Black Pearl*. This two-masted boat was a square rigger. Schock taught mechanical engineering at

the University of Rhode Island for more than 35 years. . . . **Henry C. Stillman** of Amherst, Mass., died December 21, 1988. He owned and operated the Stillman Shoe Co. in Lawrence for many years before retiring in 1962. . . . **Robert S. Cook** of Fort Lauderdale, Fla., died February 21, 1989. Cook graduated from Harvard College in 1917 prior to coming to MIT. He spent over two years in military service in World War I, surviving many severe battles. After graduation at MIT, he worked for two years with the Illinois Highway Department. He then returned to western New York where he supervised the construction of highways for 30 years. . . . **Roderick K. Eskew** of Sanibel, Fla., died March 4, 1989. I used to see Rod in Florida during the winter. He held 286 patents for products and processes, including the synthesis of rubber from Russian dandelion plants. He was proudest of his patent for powdered whole milk. Rod worked for the Du Pont Co., won a Distinctive and Superior Service Award from the U.S. Department of Agriculture, and the Harold Laker Award of the Quartermaster Corps for the invention of powdered potatoes. His wife said he enjoyed writing poetry. He was quite a raconteur!—**Sumner Hayward**, Secretary, Wellspring House E64, Washington Ave. Ext., Albany, NY 12203; **Samuel E. Lunden**, Assistant Secretary, 6205 Via Colinita, Rancho Palos Verdes, CA 90274

22

Several old friends have passed on. **Robert Hall Brown** died January 6, 1989, at age 95. Born in Fitchburg, Mass., he came to Tech after preparation at the General Electric Engineering School and Lowell Institute. Most of his career was with Parks-Cramer Co. of Fitchburg, where he was its secretary for many years. Brown was a valuable long-time member of the Alumni Council, regularly driving down from Fitchburg for the monthly meetings. I knew him well over the many years of our contemporary service on the Council. He is survived by two sons, Rev. John F. Brown of Nashville, Tenn., and Robert H. Brown of Greenwich, Conn., a daughter, Barbara Robinson of Santa Fe, N.M., nine grandchildren and six great-grandchildren.

Yen-Ting Chou died February 13, 1989, in San Jose, Calif., at age 91. He grew up near Shanghai and was a 1916 graduate of Ching Wah University in Beijing. After textile training at Lowell Textile School, he came to MIT as a junior on a U.S. scholarship. After graduation, he returned to China to have a successful engineering career. In the '30s he supervised the building of the Chang-Nang Railroad, a privately owned line, becoming its president in 1934. He also helped build several silk factories in China and oversaw construction of a silk factory in Mysore, India. When the Communists took over after the war, he and his family fled China, going first to Hong Kong, then to Japan, and in 1955 to this country. I have no word as to his activities from then to the present. He is survived by a son, Albert Chou of Monte Sereno, Calif., three daugh-

ters, Mildred Chang of Mill Valley, Calif., Marcelle Fisch of New York, and Micheline Chou of San Jose, seven grandchildren, six great-grandchildren, and a sister, C.M. Yu of New York. His wife, who died in 1975, was Yvonne Chang, a student at Wesleyan University at the time of their meeting. They married in Shanghai in 1925. Y.T. and I sat next to each other in Professor Schell's classes, probably more to my benefit than his.

John Raymond Daesen died in Park Ridge, Ill., on March 9, 1989, at age 88. Daesen was a metallurgical engineering consultant in the Chicago area many years before retiring. An expert on galvanizing processes, he held several patents in this field and wrote a book on the subject. He was a singer and violinist of considerable ability. At Tech, he played first violin in the MIT Orchestra during his freshman and sophomore years. He is survived by a daughter, Phyllis Swayne of Middletown, Pa., a brother, Alfred B. Daesen of Santa Monica, Calif., a sister, Florence D. Murphy of Watertown, Mass., and several nephews and nieces.

Samuel I. Zack died February 19, 1989, in Boca Raton, Fla., at age 88. Zack, a native of Lithuania, prepared for Tech at the Athol (Mass.) High School. He was for many years with Gannett Fleming Corrdry & Carpenter in Harrisburg, Pa., retiring as vice-president. He is survived by his wife, Dorothy (Halprin), to whom he was married in 1938, a daughter, Harriet Murphy of California, a sister, two brothers, and one grandchild. Zack regularly attended our five-year reunions, including the most recent one in 1987. . . . **Paul John Alwin Zeller** died December 13, 1988, in Bryan, Tex., at age 89. Zeller entered Tech as a junior after graduating from the University of Rochester. He worked at Texas A & M College for 40 years as director of the water pollution control facility. He is survived by a niece, Gretchen Mott of Lockport, N.Y., and five great-nieces.

Our regrets and condolences are extended to the families of these worthy classmates.—**Yardley Chittick**, Secretary, Rte. 1, Box 390, Ossipee, NH 03864

23

As I write this, the temperature is 70 degrees, the crocus blooms are long gone, the countryside is yellow with forsythia, the narcissus and tulips are in full bloom, and magnolias, Japanese crabs, and cherry trees are about to burst into bloom. By now, you should have read our plea for quips as to what you have been doing that might be of interest to your college mates. Having said this, I must report the death of three of our classmates. Earl Erickson, '29, sent us a newspaper clipping of the death of **Andrew G. Crowley** on February 16, 1989. Born in Ware, Mass., he prepared for MIT at Dorchester High School and Boston Latin School. While an undergraduate he was a member of Phi Kappa Theta fraternity. After graduation he was associated with several companies, retiring as Pacific West Coast manager of Northwest Engineering Co., with offices in San

Francisco and Los Angeles. He married Irene Vanderman of Willimantic, Conn., and they had two children and four grandchildren.

Charles K. Miller graduated with our class after previously receiving a B.S. degree in 1921 at Gettysburg College. At the Institute he was on the baseball team, track team, Mechanical Engineering Society, and Corporation XV. He married Lorene Roth of Gettysburg, the city of his birth, and had three children and several grandchildren. After graduation he joined Armstrong Cork Corp. and became director of labor relations, retiring in 1964 to become a consultant in labor relations in Lancaster, Pa.

Howard T. Clark died December 29, 1988. He was born in Dover-Foxcroft, Me. He prepared at Phillips Exeter Academy, attended classes for three years at the Institute, and later took extension courses at the University of Maine. While at the Institute he was on the swimming team and Chemical Society. He was a chemist with Lever Brothers, following which he was administrative assistant to the Secretary of State of Maine, and later he became assistant director of the Maine Motor Vehicles Department. He married Louise Cates, who predeceased him.

Best wishes to all, and exercise your penmanship.—**Frederick O.A. Almquist**, Secretary-Treasurer, 63 Wells Farm Dr., Wethersfield, CT 06109

25 65th Reunion

A brief note from **Arthur M. Sharp** is much appreciated. He reports that he winters in Florida and comes north for the summer months. He has spent much of his time traveling: he has been around the world four times, sailed on most of the major rivers, and last spring visited in Holland at tulip time. Art adds, "otherwise, not retired but *retreaded*."

The passing of two classmates must be reported. **Flavel D. Ray** died on November 26, 1988, at the Medical Center in Milton, Mass. He was employed as an advertising copywriter for Horton, Church, and Goff of Providence until his retirement in 1971. He had also previously worked for the firms of Chambers and Wiswell Co., Chirurg and Co., and the United Drug Co. Mr. Ray was a member of the Knights of Columbus in Milton and was a past grand knight of the Peabody Knights of Columbus. He leaves his wife, Emily, a son, a daughter, and a brother.

Frank H. Riegel died on March 23, 1989, at St. Vincent Hospital in Worcester, Mass. His home was in nearby Leicester where he had lived for 52 years. Frank was advertising manager of Androck Co. and its predecessors, Androck Inc. and Washburn Co. in Worcester, for 20 years before retiring in 1971. He joined the sales staff of Washburn Co. in 1942. He was a life member and past president of Worcester Ad Club and was once voted its man of the year. In 1970, he received the club's Silver Medal Award. Frank was a member of Leicester Federated Church, its Mens Club, Leicester Senior Citizens Club, Greendale Retired Men's Club in Worcester, and a life member of Leicester Lions Club. He served on the Leicester Memorial School Building Committee and Leicester High School Building Committee. Frank is survived by his wife, Marjorie, a son Edward of San Francisco, a brother John of Kennett Square, Pa., and a grandson.—**F. Leroy "Doc" Foster**, Secretary, 434 Old Corners Rd., P.O. Box 331, North Chatham, MA 02650

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Leo Teplow of Tempe, Ariz., writes that he "authored a volume entitled *Regulating Safety and Health: A Working Model*, published this year by the American Society of Safety Engineers. So far, the reviews are better than the sales." After graduation, Leo continued his education and became a lawyer. His industrial connections led him

to Italy, where he worked in Rome on the Marshall Plan, and to other countries. . . . A book by **Bill Meeham** shows that he was in industrial relations in the U.S. Patent Office.

Thomas T. Neill of Washington, D.C., died July 29, 1988. He was chief of Research and Development for NASA from the time the first space shots were launched until his retirement in the 1970s. Just before his death from an extensive heart attack, he had completed writing a technical history of aircraft engines, from the Wright Brothers to the present, which will soon be published by the National Air and Space Museum. . . .

Charles G. Moody, also of Washington, died May 24, 1988. . . . **Richard W. Batt** of Wethersfield, Conn., died January 2. . . . I am sorry that no details about their accomplishments are available.

Morris Minisk of Chelsea, Mass. (who like his friend Bill Meeham worked in the Patent Office), has been to all of our reunions and many other MIT activities. He sure wants to continue. He has trouble with one ankle and has just had a cataract removed from one eye. But with the help of his nephew he hopes to be with us at both Technology Day on June 9 and the Cardinal and Grey Society June 10. He says hello to all of you.—**Donald S. Cunningham**, Secretary, 27 Lowell St., Braintree, MA 02184

27

We are sorry to report the death of Hope (Case) Fisher, wife of class president **Harold (Bud) Fisher**, in Duxbury on April 14, 1989. She had been an invalid for a number of years and Bud has taken the best of care for her. They have lived in Duxbury for 19 years and have a son Dean W. Fisher of Duxbury and three grandchildren. Our sympathy is extended to Bud and his family.

Lawrence (Larry) Grew writes that Hope attended Whitman grammar school and Brockton High School with him in the Class of 1923.

A note from **Theodore (Ted) Ordman** of Masaryktown, Fla., in the winter and Stanfordville, N.Y., in the summer answers my question concerning the disposition of his class file. He gave the name of his wife, Valda, and his nephew with his address. A patent lawyer all his career life to 1977, Ted sets an example of courage in overcoming his complete loss of hearing in 1932 by lip reading. In addition, in 1984 Ted suffered a compound fracture of his left ankle and is unable to walk unaided and gets around with his walker.

Thomas Russell writes from his large home in Naples, Fla. He said he spent a year in Claremont, N.H., as trainee at Sullivan Machine Co. immediately after leaving MIT and enjoyed every day of it. "Betty and I are quite disenchanted with Naples. No longer is it the quiet little fishing village that I first visited 35 years ago. The worst thing that has happened is the new hotels—the Ritz Carleton and the Registry. Now Miami Beach moves to Naples each week-end." Their home is situated on a lake that is owned by the 27 abutting property owners, so they are protected from the hustle-bustle of the beach.

William M. Lempka died on October 11, 1988, at Lakeland, Fla. A civil engineer, he retired from Davy McGee Corp. in 1968 to care for his wife who was ill. A note from his second wife, Helen, said they travelled quite a bit until he had a stroke in 1973 and later a heart attack. Bill has not been very active since then. He was a member of St. Joseph's Catholic Church. "Bill was a wonderful man and will be missed greatly." Besides his wife, he is survived by a son, two daughters, 18 grandchildren and eight great-grandchildren.

Jennings B. Hamblen died on March 3, 1989, in Franklin, Ind., at age 91. His widow Virginia writes, "He was born November 6, 1897. Graduated from Franklin High School in 1917, and the University of Wisconsin in 1921 with a degree in

chemical engineering. He worked for the US Gypsum Co. in Nova Scotia before attending MIT where he received his M.S. in chemical engineering in 1927. He then worked for Standard Oil Co. (Amoco) Chicago for 35 years retiring in 1962. We spent our retirement years in beautiful Brown County, Ind., and moved to a retirement home in Franklin in 1985. He loved gardening and spent many hours in the garden growing roses and other beautiful flowers."

Thurston K. Decker died on March 2, 1989, in Gulfport, Fla., of congestive heart failure. His widow Louise writes, "He was born in Montgomery, Pa., attended Susquehanna University and MIT with a BS in chemistry. He was active in the United Presbyterian Church and served many years as an elder, and as a delegate to the General Assembly in the 1960's. He was with Philco-Ford for 28 years leaving as corporate staff purchasing agent, to go to IRC-TRW as director of purchasing for 10 years. From 1956 to 1984 we travelled all over the world. The last few years of his life Thurston was less able to get around, but he kept active mentally and enjoyed the last years of his retirement." He is survived by his widow, five children, 18 grandchildren and seven great-grandchildren. He remarked on his 30th reunion questionnaire: "The major accomplishment of my wife is to make life worth living."

Finally a kind note from **David Knox**. "We are getting closer to that last moment on this orb. Our life seems like a fleeting second—the high point being our years at MIT. Remember how slowly things seemed to move as an undergraduate, we could hardly wait to get out into the world of business. Now there is never time to finish every task. Life is so fleeting."

"Joe, what a job you have done over the years in keeping us informed about the activities of our classmates. Your reward is only knowing that you contributed to the happiness of fellow humans. I want you to know how much I appreciate the hours you have spent on this volunteer effort. Many thanks, Joe, and you may send the contents of my file to my wife, Jean, at this address when I have departed." Thank you Dave.—**Joseph C. Burley**, Secretary, North River Rd., Epping, NH 03042; **Lawrence B. Grew**, Assistant Secretary, 21 Yowago Ave., Branford, CT 06405

28

Earlier this year we had a telephone call from a gentleman who was seeking some information relative to his father (and our classmate), **John P. Luby** (deceased in 1961). The question pertained to the subject matter and title of our Jack Luby's undergraduate thesis. To us it was something of a surprise to learn that all of our S.B. theses of six decades ago are still on file in the Institute archives. It was a further surprise to learn that Jack's thesis partner was **Abe Wolf**, our good 60th reunion chairman. Abe was pleased to hear of this echo from the distant past and hopes to hear from the younger Jack Luby.

Frannie Donovan was very pleased to receive notice that the MIT Sustaining Fellows program had donated a book entitled *Mixing Equipment*, by the American Institute of Chemical Engineers, to the Science Library in honor of **Jim Donovan** and in recognition of his loyal support of the Fellows program. A copy of the dedication bookplate was sent to Frannie who will also continue with Jim's Sustaining Fellows membership and title.

The Cardinal and Gray Society is an MIT alumni group from those classes that have been out 50 years or more. In addition to those distinguished alumni and alumnae, membership is open also to respective spouses, widows, and widowers. Until now activities of the society have been limited to two meetings per year and attended by those in the New England area. Consistently the meetings have been highly enjoyable and colorful occasions. We say "colorful" because many of the attendees wear the traditional cardinal jackets at each event and one dear lady was heard to ex-

claim: "The men are so handsome with their white hair and red jackets!"

In view of the ten years of success locally, an effort is being made now to apply the Cardinal and Gray idea more widely. As a start, the 1989 Technology Day plans have included a hospitality center in McCormick Hall where those of the older classes can gather, rest, and socialize. Here also will be a source of information, guidance and assistance to attendees. Our next column will have a report of this first trial.

No doubt, at this time of life, some of you have been regarded by young relatives as ambassadors from a far distant past and so ready to answer all questions of family history. Well, Florence and I (your secretary) are in that position. We have found that one partial solution to the general problem is to show the inquisitors old family movies that may have been in storage for up to a half century or more. The subjects and characters have changed (or departed) over the years, of course, so now only we can tell what and who they are. This has led to our present project of transferring these old film treasures to videotape with our own explaining voices dubbed in. Such transfers can be done professionally but vital information that can be supplied only by knowledgeable narration is then lacking. If left in silence an otherwise good movie could be nearly useless in a few years. So we are doing the whole job at home. Our technique (already tested) is first to edit and assemble our old 8-mm movie film shots and strips in chronological order. The full reels are then projected in sequence on a small white screen to give a good bright image. During projection the screen image itself is recorded with a full size camcorder properly placed, secured, and focussed. Narrating is done with an extension microphone so as to be remote from the noise of projector and camcorder. We intend to make one master set then duplicates to fill any family requests. . . . Do any of you have thoughts or experience to contribute?

With deep regret we must report that **Bruce E. Sherrill** died February 13, 1989. The information came to us from his wife, Elisabeth, through the Alumni Fund office. Bruce graduated in Course I, civil engineering. To Elisabeth and her family we extend our heartfelt sympathy.—**Walter J. Smith**, Secretary, 37 Dix St., Winchester, MA 01890; **Ernest H. Knight**, Assistant Secretary, Box 98, Raymond, ME 04071

29

All his life, **James Reddig** of Webster, N.Y., has been involved with airplanes and flying. As such, I received a brief note saying, "I am still chasing airplanes. Hope to attend our 60th reunion in June." . . . **John Happel** of Hastings-on Hudson, N.Y. has sent me a note: "I am still at Columbia University and CRC, but we found time for a short trip to France and the Caribbean. We are looking forward to attending our 60th reunion at MIT this June. After that we will be going to Lake Placid as usual for the summer. Best wishes to all." . . . **Louis Southerland** of Austin, Tex., sends a note: "My wife Jeanie and I are in good health and travel together often. We went to Italy last fall, Mexico in the winter. In May we will be going to southern California for two weeks of watercolor painting. In September, we plan to spend two weeks painting in Maine. I also hunt quail, doves, and turkeys when I get a chance. I do appreciate getting such a nice birthday greeting every year." Louis was a successful architect who retired in 1979. He was the co-founder of Page, Southerland and Page, located in Austin, Houston, Dallas, and Corpus Christi, employing over 135 professional, administrative, and clerical workers. His firm designed many notable structures including the Supreme Court Building for the state of Texas, Stark Museum of Art in Orange, Tex., numerous buildings for the University of Texas, Texas Women's University, and many others. Louis is a fellow of American Insti-

tute of Architects, and a commander in the U.S. Naval Reserve, having served in World War II.

Prof. **Fred S. Eastman**, who now lives in a retirement complex in Medford, Ore., has moved into a larger apartment. His hobbies are walking, lawn bowling, and croquet. He arranges walks, hikes, and lawn bowling for his fellow residents.

. . . **Hunter Rouse** of Sun City, Ariz., writes, "Your good birthday card and note arrived right on the dot, and I thank you for it. The same post brought another congratulatory letter from the Iowa Engineering Society honoring the 'Best of 100' in its centennial year. Earlier in the year, Iowa University had established a professorship in hydraulic engineering in my name. I fear that we shall have to miss our 60th reunion, what with a slipped disk apiece. We shall not even make our usual summer trek to Colorado for the first time since 1976. Doi joins me in best wishes to you, Helen, and the rest of the classmates."

Every spring, our class agent **Bill Bowie** and his wife Sally take a leisurely motor trip to south Florida, visiting MIT friends on the way down. I called Bill in March and asked if they were planning such a trip this year because I thought they would like to join us when we called on Helen Hamilton. We had not seen her since Hugh passed away in January, 1980. My wife and I were able to arrange a dinner meeting with her. After a tour of her newly renovated house in the Royal Palm Way complex on the Intercoastal Waterway, we went to a lovely restaurant and had a wonderful time talking about mutual friends and classmates. Hugh and Helen were active in MIT affairs. They were on our reunion committee and attended a number of our major reunions. Helen lives on their estate in Durham, N.C., and in Boca Raton, Fla. Hugh had a stroke in January 1970, which left him paralyzed from the waist down and confined to a wheelchair. A number of classmates, including **Frank Mead**, **Bill Bowie**, **Gus Stein**, and myself visited him regularly at his home in Florida until his death.

I regret to announce the death of **Joseph H. Durkey** of Jacksonville, Fla., on December 16, 1988.

For the benefit of those classmates who wish to contact me by phone, from December to May my number is (407) 395-2890. The rest of the time, I can be reached at either (603) 926-5363 or (617) 643-8364.—**Karnig S. Dinjian**, Secretary, P.O. Box 83, Arlington, MA 02174

30

60th Reunion

As mentioned in last month's notes, I decided to hoard for this issue items in the letters that Yicka received in response to the first 60th reunion mailing. Upon reviewing these letters, I find that a certain amount of editing seems necessary in order to avoid repetition and include only new items. While I appreciate the time and effort you devote in preparing some life histories, I hope you will not be offended by this winnowing process.

Ted Bridge notes that his and his wife's health problems will prevent them from attending the 60th. Ted reminisced about a 1929 trip that he and **Paul Kimberlein** made in Paul's model "T" to the R.O.T.C. camp in Aberdeen, Md. Among other things, they ran out of gas at the intersection of 42nd St. and Fifth Ave. (fortunately a good-humored traffic cop was on duty), and had considerable trouble finding a gas station nearby. Ted says that "after getting lost in the bowels of Newark, Hackensack, Paterson, Elizabeth, Trenton, Philadelphia, and Baltimore, we didn't have too much trouble getting to Aberdeen." . . . One evening **Ben Buerk** drove a group of us to Havre de Grace for a beer. This seemed to be a crumbly town, and we went to the last street in the crumbiest part of it. Upon entering the cellar of the last house on the street, we saw people drinking beer at small tables, around which several prostitutes were plying their trade. In a way we were quite at home. At least the language was what

we were used to in the barracks."

David (Tul) Houston reports from Hilton Head, S.C., that since his wife, Anne, became partner of a travel agency, they have taken a number of *Royal Viking* cruises, including one last year from Copenhagen to Leningrad. David found "Leningrad the 'Jewel of Russia,' interesting, especially the magnificent Hermitage Museum. But the city otherwise is a dirty, rundown dump." (Louise and I ended a Russian tour in Leningrad last year and would give it a better rating.) As of April 1989 the Houstons were booked to sail from Ft. Lauderdale to and around the Mediterranean. . . .

Morris Young, whose activities have been extensively reported in previous issues, is still engaged full time with his son Charles in the practice of ophthalmology. He is also a member of the executive council, New York Chapter, of the Association of Military Surgeons.

On a personal note, your secretary was the speaker at the annual meeting of the MIT Club of Tucson on April 8. My talk, entitled "Famous Patents," involved showing about 20 slides of patents covering inventions that have contributed significantly to U.S. technology.

We have received notices concerning the deaths of three classmates: **Francis S.F. Leong** last November 9, **George Shrigley** on February 10, and **Bill Spahr** on March 30. Unfortunately, the only information I have on Francis is that he died in Honolulu, where he had lived for many years. . . . After graduating from MIT, George Shrigley earned a law degree from Boston College but apparently never practiced law. Instead he became a pioneer in the shopping-center industry. In 1952 he took over the management of Shoppers' World in Framingham, Mass., one of the earliest such centers, and eventually retired as its vice-president and general manager. He was an active member of the International Council of Shopping Centers, lectured on shopping centers for many years, and prepared and edited the basic documents the council used to publish its first *Forms Manual*. George was also active in civic affairs. His directorships included the South Middlesex Chamber of Commerce, Visiting Nurses Association, Family Counseling Service, and the Framingham Union Hospital. He was also a member of the Route 9 traffic study and zoning bylaw committees. . . . For most of his career Bill Spahr worked for Metropolitan Life and lived in Smithtown, N.Y. At the time of his retirement in 1973 he was director of the Budget and Cost Department at the company's home office in New York. As a reserve officer in the Army Signal Corps, he was called to active service in 1941 and served both overseas and stateside. During the Korean war he acted as liaison officer between the Pentagon and Wright Patterson Air Force Base in Ohio. In his spare time Bill was an avid golfer and bowler. He was also president of the Smithtown Booster Club and a member of the Village Planning Board. He is survived by his wife Muriel, son Jonathan, daughter Lucia, and five grandchildren.—**Gordon K. Lister**, Secretary, 294-B Heritage Village, Southbury, CT 06488

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A note from **Al Sims** says, "In November 1988 Lillian and I took a trip by boat across Florida on the *New Shoreham II* along with **O.M. Burrows** and Kay, '32, leaving from West Palm Beach, intra-coastal waterway through Lake Okeechobee, several stops along Florida's west coast, ending in Key West on December 7–12 days of pure fun. On the trip was another member of our class, **John Gardner**, whom neither of us had known at Tech!"

A note from **John Dodge** brings us up to date on his retirement activities. "Teaching advanced-placement physics in two local high schools [near Pensacola, Fla., I presume], helping prepare seventh edition of *PSSC Physics* (a high-school course originating at MIT in '57), doing chores for my church, bicycling, and mountain hiking."

Always with regret, we have deaths to report. . . Notice of Commander **Frederick A. Dartsch** of Chicago, December 6, 1987, reported by his daughter Mrs. Ann Wrampelmeier of Washington, D.C. . . . Colonel **Hally Z. Bogert**, December 3, 1988, Santa Barbara, Calif., reported by his son Bob of Marina Del Rey. Colonel Bogert had an active career in the armed services, NASA, and the aeronautical industry.

Chuck Turner writes, "I have sold my property and casualty insurance business, but still retain my business as registered representative for dealing in all types of securities, which is less demanding. So I guess I'm, say, 80% retired. Best regards to all remaining classmates."

As I write this I have just been talking with **Ed Worden's** wife Helen. Ed had a very serious heart attack just two weeks ago (Mid-April). He is now in a nursing home nearby; recovery has been slow but is definitely progressing. We all hope he will be back in his vital spot in our class again soon. Here is his well-known address for all who wish to send him notes: Edwin S. Worden, P.O. Box 1241, Mt. Dora, FL 32757.—**John R. Swanton**, Assistant Secretary, 27 George St., Newton, MA 02158

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Alfred Mulliken has completed four years on the board of directors (with the last year as president) of the Whiskey Creek Golf and Country Club. He is currently in his 14th year of service with SCORE in Fort Meyers. He is also active with the MIT Club of Southwest Florida. . . **Adolph Warsher** had a heart attack that triggered his retirement. He was a consulting engineer for Mitre Corp. and C.S. Draper Corp. Now he is writing science fiction. He and his wife, Virginia, are now reasonably healthy. . . **Jacob (Jack) Millman** tells us his wife, Sally, had Alzheimer's disease for over two years. She passed away in July 1988. Jack has moved to a retirement campus at Lake Pointe Woods A102, Sarasota, FL 34231.

John William Leslie's son, Stephen Leslie, '70, is collecting anecdotes about his father. This will be for an oral history for John's children. Stephen recalls that his father was not much of a talker, and he always seemed to be at work or in Washington D.C. (He spent 44 years with the U.S. Army Corps of Engineers.) He was sort of a bridge between Congress, the public, and the engineering/construction industry. If any classmates have any anecdotes about John, please forward them to: Stephen K. Leslie, 2744 Sacramento St., Suite 305, San Francisco, CA 94115.

Thomas H. Anderson gave us his new address: 100 Thornhill Dr. No. 213, San Raphael, CA 94903. He is always glad to hear from or see his classmates. . . I enjoyed talking with **Charles Pierce**, who has worked with the Boston Weather Bureau for many years. Perhaps his most spectacular experience was with the 1938 hurricane. . . **Frederick B. Hoyle** writes that he missed my telephone call during a telethon, but his wife enjoyed talking with me. Fred promised to write me a letter and bring me up to date concerning his activities.

William Clark died in June 1988, shortly after his wife, Phyllis, died. William was retired from the State of Ohio Public Works Department, and North American Rockwell. They leave behind a son and daughter. . . **Morris Newman** died last February after a long illness. He was involved with the Manhattan Project and a major supporter of Technion Institute of Israel. He is survived by his wife, Beatrice, two sons, and two grandchildren. . . We have also received information that **Ray Hawksley** died in May 1987, and **Max Richmond** died in September of last year. When we receive more obituary information, we will pass it on.

I would like to include pictures each month in my class notes. Please send some!—**Melvin Castleman**, Secretary, 163 Beach Bluff Ave., Swampscott, MA 01907

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We all hope that the Cardinal and Gray Society reunion on June 8 and 9 was a success.

As some of you may have noticed this prestigious magazine reported my demise in the April notes, subject to further reading which reinstated me. *[A most unfortunate typo—our red-faced apologies!—ed.]*

Bill Huston of Lady Lake, Fla., is the only one courteous enough to remark on it. Anyway, I am still here (or was May 1). Huston's younger daughter was married last November in Phoenix and his older daughter followed suit last May in their old hometown of Bowie, Md. After the wedding, they spent three weeks in Yugoslavia. Bill asked about **Beau Whitton**.

Beau is apparently very fortunate to have chosen an ideal spot (with medical facilities) for retirement. And he has a son and daughter-in-law devoted to him. His address is Sharon Towers, 5100 Sharon Rd., Apt. 319, Charlotte, NC 28210. Although notes must be read to him several times, I understand he very much appreciates hearing from classmates.

At Huston's urging, I spoke to **Quimby Duntley** in or near San Diego, who promises to send me a retiree resume.

Obituaries. **Jack Andrews** reports the death of **Mel Ehrlich's** wife Sylvia, in Browns Mills, N.J., the only address we have. . . **John Williams** died last December 31. His career included Ludlow Co. in this country and India, G.E. and Bendix during World War II, and latterly for the Kendal Corp. in Walpole. Mrs. Williams may be reached at 44 High St., Medfield, MA 02052. . . **Lewis Burrows** died February 10 in Shreveport, La. He was retired as director of engineering, Dresser Industries. Mrs. Eva Mae Burrows may be reached at 6101 N. Weatherly Dr., Shreveport, LA 71129. . . **Asa Jewell** died February 9 in Franklin, Tenn. He was mayor of Franklin from 1961 to 1969. He was active in the Rotary Club, operated tobacco warehouses, and bred horses. Mrs. Jewell lives at 340 4th Avenue S., Franklin, TN 37064.

This column is beginning to resemble an obituary and nothing else except for one or two stalwarts. Before we receive your obituary, it would be nice to reveal something about yourself. And who knows, you may hear from people long since forgotten whom you really cared about. If not now, when?—**William B. Klee**, Secretary, Box 7725, Hilton Head Island, SC 29938

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55th Reunion

Bernie Nelson announces that **Goffe Benson** is serving as chairman of our 55th reunion committee. We plan to start the reunion on Wednesday, June 6, 1990, at M.I.T. and leave for the Cape on Friday, June 8, to stay until Sunday, June 10. A reunion committee meeting will be held in the fall to confirm this. On April 12, M.I.T. held a reunion planning dinner meeting at the Student Center for classes having reunions in 1990. In attendance for our class were **Bernie Nelson**, **Goffe** and **Marie Benson**, and **John Talpin**. Goffe was chairman of the M.I.T. portion of our 50th reunion.

Words of wisdom from **Walter Stockmayer**: "If you really are determined /Not to spill the marriage cup/. Then when you're wrong, admit it./And when you're right, shut up!/. . . **Walter Godchaux** writes from Slidel, La., "I retired in mid-1983, after selling the business I had been principal owner and CEO of since 1956. At that time we moved from New Orleans to Slidel, 35 miles from New Orleans on the north shore of Lake Pontchartrain. We purchased 6 and a half wooded acres in 1981 and completed our house in 1983. We have a small fish pond on the property, and I have a shop in which I can do woodworking and general repair and minor improvements to the property. We have a swimming

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pool, and I raise vegetables as well as flowers. . . **Frank Hatch** writes from Burlingame, Calif., "I attended M.I.T. for two years and would have continued, but my parents moved from New Jersey to Longview, Wash., in my second year and wanted me nearer home. I transferred to Stanford and graduated with distinction in petroleum engineering in 1935. I worked for Shell Oil Co. from June, 1935, until retirement in 1974, except for 3 and a half years in the Navy. With Shell, I worked in manufacturing and marketing, finishing as western area manager of transportation sales. In the Navy, I worked in aviation ordnance and petroleum products distribution, retiring as a commander, Naval Reserve, in 1969. I have been active in various organizations including Rotary, ASME, the Episcopal Church, Boy Scouts, Stanford Alumni Association, and Commonwealth Club of California. Hobbies include wood-working, photography and golf. [Frank played in the class golf tournament each of the 25 years it was active.] My wife and I have been married 50 years and have two daughters and two grandchildren."

I am sorry to report the deaths of two of our classmates. **Leonard S. Wiener** died in Mission Viejo, Calif., on November 16, 1988; and **Dexter Stevens** died February 17, 1989, in Wells, Me. Stevens served in the Coast Guard in World War II and for many years was employed by Uniroyal Tire Co. He was a former town chairman of Wells and a retired commander of the U.S. Coast Guard. He is survived by Virginia, his wife of 44 years, and two sons, a daughter, three brothers, a sister, and four grandchildren. I am sending condolences from us to the two widows.

After a month-long gap in my part-time job picture, I have been hired as bookkeeper for the Well Doctor. This is a year-old company in the business of water well evaluation, maintenance, and repair. They have a unique service to offer: a video tape of the inside of the customer's well made by lowering a camera. A screen display takes you literally down the well during the process. It is a most convincing sales tool. Four days after I started, I became office manager. The sky's the limit for this company, or I should say the center of this planet is the limit. . . . Where are all those letters?—**Allan Q. Mowatt**, Secretary, 715 N. Broadway, Apt. 257, Escondido, CA 92025, (619) 432-6446

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On the road again, going north along the New Jersey shore after a family wedding-anniversary celebration, I stopped in Spring Lake to visit **Phil Slater**. Phil met **Eli Grossman** early in sophomore year at the Institute, which Phil entered after a year at N.Y.U. He was taken with Eli's aim to become an actuary, and joined him in Course XVIII. Phil continued with some graduate work at Princeton and was with Equitable Life for 25 years before going into consulting. Later he was executive vice-president of Federal Pension Bureau, Inc., and ultimately bought into a firm that became Woodward and Slater, in which he is still active. Phil played the violin in the New Jersey Symphony from 1938 to 1943, and he and wife Cecile have two talented daughters, both M.D.s. Cecilia won a Marshall Scholarship for a year at Cambridge University, and is one of a group who hold a diploma ('81) jointly from MIT and Harvard's Division of Health Sciences and Technology. She is a pianist. Eve's ability as a flutist caught the attention of Arthur Fiedler, and she once played a Mozart concerto with the Pops.

Farther north I found **Bob Parker** at home in Keyport watching the Masters Tournament of his favorite recreation. Bob joined us in 1934 (Course V) as a graduate student with a B.A. from Tufts. But his father died and he could not finish in '36. So he went to work and got a variety of assignments that moved him from National Lead to Fort Dix to Esso and finally 24 years at Foster Wheeler. Along the way he took night courses,

and got his S.M. at Newark College of Engineering. His eyesight is below par, but he is hearty and at 77 "better than 10 years ago."

When the new Alumni Directory is delivered, you will find **Nelson Tower's** business address as Black River and Western R.R., Ringoes, N.J. This is a 20-mile-long freight (and lately sight-seeing) connecting line from way back, which he bought into years ago. Who wouldn't like to run a full-sized railroad rather than a model? Nelson started in Course VI-A but switched to XV. After World War II he went into the construction business but found consulting work "less risky and more fun." So for some 30 years he has planned, consulted, and managed costs, and built hospitals (e.g., Sloan Kettering, New York Hospital), college buildings (Rochester Institute of Technology), and the huge radio telescope in Puerto Rico, "on time and under budget." His firm of Wood and Tower developed computerized methods of cost estimating. Nelson sold the firm to McGraw-Hill and retired to railroading in 1979.

From Ringoes I motored over to Pipersville, Pa., and was the guest of **Roman Ulans** and wife Morwenna—a very comfortable and pleasant overnight stop. As the 50th biographies show, Roman spent 25 years in the Army Signal Corps, retiring as colonel, and then had an almost equal tour with Comsat. In both endeavors he made good use of his Course VI-A fundamentals, and had fascinating experiences in various parts of the world. His citations include one from Korea, in their unique language and alphabet (only 28 characters, not thousands of ideographs). Ro and Morwenna have collected rugs, brass, and other decorations from several countries, which give their home a warm touch.

Then on to Pennington, N.J., and lunch with **Fred Assmann** (Course X) and Mary, another couple with two achieving daughters. (Not surprising—Mary also got an S.B. in chemistry, at Duquesne.) Daughter Susan was a Dartmouth B.A., then Ph.D., '83, at the Institute. For the latter she had to choose between two fellowships she won: from AT&T and the National Science Foundation. Daughter Sarah was a Williams B.A. and earned her Ph.D. at Stanford in plant physiology. She also won an NSF fellowship. Both are professors, at Lowell University and Harvard respectively. Fred and Mary had lunch with **Walt MacAdam** and Rilla last year when visiting mutual friends in Thetford, Vt.

A few days later, heading for New England I made a detour to Fishkill, N.Y., and saw **Jim Craig** at work. He is consulting for Dempsey Enterprises on a full-time basis—after 32 years at Union Carbide-Linde, where he knew **Tony Hittl**, **Pat Patterson**, and **Lou Smith**.

On to Waterbury, Conn., and **Mike "Angie" Tremaglio** and Edith for a delicious lunch and much conversation. Mike related how his long-time friendship with **Ed Dashesky** developed from their cooperative study for final exams: Ed was commuting from his home in Dorchester and invited Mike, a dorm resident, for a weekend of peace and quiet. The two worked together; Ed's mother fed them nights and weekends, and they passed. Mike, **Nelson Tower**, and **Charlie Hobson** should get together to swap tales about their experiences in construction: Mike's firm, begun by his older brothers before 1932, built court houses, post offices, a USO building, a veterans hospital, etc. Edith showed me a charcoal sketch by their son Richard ('68 and a professor in Course IV), which to me suggests Michelangelo's David, side view—excellent!

Harry (William H.D.) Shewbridge (Course II) in Cheshire, Conn., was busy caring for his wife who had just returned from the hospital, so we met on the telephone. He explained that his family always used his first middle name Harry because his grandfather and father were also Williams. Harry entered as a freshman in the class of 1934, but took two years after sophomore year for gainful employment to replenish the exchequer, finishing with us in 1936. He retired as chief engineer with Scovill, Waterbury, Conn., in

1975. . . . On to President **Alice Kimball's** in Hartland and a review of my card file of anticipated visits. Alice provided helpful information: **Ruth Perkins** in Sudbury, Mass., has Alzheimer's disease; **Towers Doggett** has been in touch with the Maine contingent and can fill me in; a meeting of the class officers was to be held at **Eli Grossman's** April 22; and Alice will host the mini-reunion at West Hartland October 28. Mary Assmann will be the organizer and can be reached at (609) 737-1456, or by mail: Mrs. **Frederick F. Assmann**, 17 E. Curtis Ave., Pennington, NJ 08534. All are welcome, and from any distance, any time after 11 a.m. on the 28th—just contact Mary first, or Alice. Planning for the 55th reunion will be discussed.

With space limitations, it will take a few more issues to cover the rest of the trip. Distances between classmates are shorter in the northeast, few were away, and in 10 days I was able to reach about 30. So I will list all their names now and ask that you wait for individual reports in the coming months: **Wendell Fitch**, **Walt MacAdam**, **Fletcher Thornton**, **Towers Doggett**, **Bill Greenwood**, **Paul Richardson**, **Phil Grant**, **Doug Woodward**, **Ken Swain**, **Ed Rowe**, **Bill Wu**, **Bob Newman**, **Bill Hastings**, and **Ed Ferris**. By telephone, or messages left with wives, under doors, or on answering machines: **Ray Woodrow**, **Bill Healy**, **Harold Brown**, **George Parkhurst**, **Baxter Moore**, **Richard Morton**, and **Elwood Kootz**. **Dorian Shainan**, **Bill Hope**, and **Felix Klock** apparently were away.

Let's close with tributes and cheers for the lives of **Roswell Peavey**, **Fred Flint**, and **A. James Ullmann**.

A clipping from the *Dallas Times Herald* says that Roswell died of cancer February 17. He was with us in Course VII after graduating from Nazarene College, and went on to Boston University for an M.B.A. His career included the Carnegie Institution, the National Bureau of Standards, the National Academy of Sciences, and U.S. executive director for the International Geophysical Year and for the Graduate Research Center of the University of Texas. In 1986 he received the Soviet Union Commemorative Medal for Geophysics. His widow Shirley's address is 912 Creekside Dr., Richardson, TX 75080.

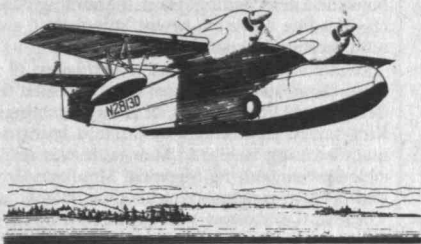
Fred Flint died last December 16. He was Course XVI and spent his work life in aeronautics—at MIT, Curtiss Wright, Lockheed, Piasecki Helicopter, and 26 years at Bell Aerospace before retiring in 1976. He loved skiing, and was a member of the National Ski Patrol for more than 25 years. His wife, Virginia, continues at 374 Rosedale Blvd., Amherst, NY 14226.

Jim Ullmann's wife, Sylvia, responding to an Alumni Office records check, noted that Jim died October 18, 1988. I have not been able to reach her by telephone, and am away from my library of directories. So I will write about him in the next issue.—**Frank L. Phillips**, Secretary, 901 Los Lovatos, Santa Fe, NM 87501; **James F. Patterson**, Assistant Secretary, 170 Broadway, Pleasantville, NY 10570

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Ross E. Black, 193 Rope Ferry Rd., Waterford, CT 06385 writes, "Still doing quality assurance consulting in southern New England area, and fighting pests (from gray thrips to deer) for control of our garden patches. (Also resumed ship hobby)." . . . **Joseph S. Dunning**, 7537 Mulholland Dr., Los Angeles, CA 90046, retired as vice-president of administration, McDonnell Douglas, in November 1979. Wife Vivian's main interest is the Art Museum (L.A. County). Joseph enjoys golf and photography. He is a member of the board of directors of the Southern California Rapid Transit District, and a member of the Long Beach Community Hospital, the Greater Los Angeles United Way, and the MIT Visiting Committee for Aero/Astro.

Alfred E. Hale, 20 Cormorant Rd., Wakefield,

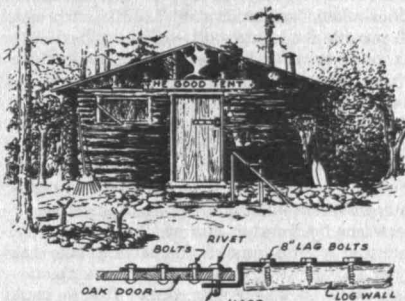


Gourmet of the North Woods

Moose Stew is, first and foremost, about hunting moose in the north woods and about eating the results. For readers who relish the hunt, and especially those familiar with the Canadian wilderness, this saga by Herbert F. Goodwin, '37, offers an entertaining glimpse into camping with an intriguing technological twist.

Not only is Goodwin an ardent and accomplished moose hunter, but he has also been a licensed pilot of amphibious aircraft ever since they became available to the public following World War II. The five seaplanes he has owned over the years have played an integral part in his adventures, giving him access to remote northern lakes and providing a means to remove the largest ingredient for his prized moose stew. Goodwin's loving descriptions of his planes, their capacities and quirks, and the logistics of bush flying provide an interesting counterpoint to the age-old nitty-gritty of pursuing big game.

Goodwin, a lecturer at the Sloan School of Management from 1940 to 1981, began his quest for moose stew in 1947. Over the next 35 years, accompanied by assorted colleagues and guides, he scouted likely lakes in eastern Canada. Staying a few weeks each year at choice spots until they became too popular, he eventually found a small cabin for sale on a lake several hundred miles north of Toronto, Ontario, near Temagami. Here "The Good Tent," as his handyman's delight was called, served as a base camp for many years of hunting and fishing.



Having mastered the arcane art of moose calling (which simulates the amorous vocalizations of courtship), and perfected a butchering technique with non-gamey results, Goodwin subsequently turned out some 45 moose stews, as well as other delicacies known as "moose balls." These tiny moose burgers were quite a hit with his classes at MIT and at the Faculty Club, where he shared his culinary skills and exploits with his colleagues one evening.

The book depicting his many adventures is a natural extension of Goodwin's desire to convey his love for moose hunting and for the outdoors. His eye for detail and flair for description set the stage for an impassioned plea at the end against the growing restrictions on hunting by politicians and others "with little personal experience" in the field.

"Moose hunting is a difficult, challenging, and rewarding task," he writes. "Precious few have experienced

the thrill of the deep woods and learned the lessons of the wild and the requirements of self-sufficiency that go with planning a hunt, outfitting it, successfully calling a moose, and skillfully butchering it so that there are several hundred pounds of delectable meat to savor over the next year or more.

"I despise the trophy hunter who seeks only self-aggrandizement and is a chest-pounding braggart," Goodwin continues. "I detest even more the poacher and the sport who kill moose only for the tenderloin and strips and leave the rest to rot." Goodwin clearly knows how to get the most out of his mooses, both in the quest and the consumption. He also has a deep appreciation for the process, and for the camaraderie of a few good friends off in the woods to challenge the elements.—Faith Hruby □



Moose Stew was published in 1987 by Cameo Books/Harpswell Press of Gardiner, Maine.

RI 02879, retired September 1976 as senior flight operations engineer at Pratt & Whitney Aircraft Engines. Wife Alma likes to read and sew, is a past president of the League of Women Voters, and formerly operated a day-care service. Alfred enjoys golfing, boating, and bowling. He was elected president of his Property Owners Association in 1988 and 1989, and is an active "pond watcher" for a coastal resources project. He and his wife celebrated their 50th wedding anniversary in May 1987, and have two children and seven grandchildren. . . . **Josiah Heal**, 605 Roundtree Dr., Longboat Key, FL 34228, retired in 1976 as treasurer of Spaulding Co. He sings in church choir in Maine and Florida, and solos occasionally. Joe writes, "My wife, Marion, has been quite

ill the past three years with Parkinsons disease, diabetes, arthritis, and edema. Have been quite busy taking care of her and keeping house. Hope we can get back to our Maine cottage in June. I hope to visit Alaska this summer if all goes well."

Sidney Mank, Rte. 1, Box 831, Washington, VA 22747, writes, "Have been busy with the "Lions" and Rappahannock Loan Closet, which dispenses free medical equipment. Still caring for two elderly parents—my mother, 98, and Dot's mother, '90. Getting ready for spring planting—vegetable and flower garden. Never a dull moment! . . . **Bill Wold** lives at 27-A Cushing St., Dover, NH 03820. Wife Louise Saunder's main interest is psychology. Bill is president of the Air Land Corp. His hobbies and volunteer work include bridge,

chess, and adult tutoring. He writes, "Spent most of winter in Arlington, Tex., where occasionally noted New Hampshire temperature warmer than Texas."

I regret to report the death of **John A. Murley** (1398 Drift Rd., Westport, MA 02790), who died January 31 at St. Anne's Hospital, Fall River, after a long illness. He was born in Bedford, Mass., and lived in Westport 34 years. John had been in business with his father, operating fishing vessels out of New Bedford for many years. He served with the army transport and maritime during World War II, was a charter knight and past grand knight of St. Isadore, the Farmer Council, No. 4373, Westport, and a charter knight and past faithful navigator of Bishop Cassidy General As-

sembly. He was a member of the Noquochoke Senior Citizen Club, and the Westport Grange, Patrons of Husbandry, No. 181. Survivors include his widow Pauline (Rioux) Murley, son David W. of Falls Church, Va., and daughter Susan J. Murley of Westport. . . . I also regret to report that **Frank W. MacDonald** (1711 Gen. Pershing St., New Orleans, LA 70115) passed away February 21, and is survived by his wife.—**Lester M. Klashman**, Secretary, 289 Elm St., Apt. 71, Medford, MA 02155

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Your assistant secretary and Jean have just returned from a wonderful three weeks touring Turkey from Istanbul across the Hellespont (not swimming) down the Aegean coast to Troy, Izmir, and Ephesus, over to Tarsus and back through Ankara and Cappadocia. We failed in our mission of getting in touch with classmate **Enver Muradogla**, probably because I had his name misspelled. However, we're now sending out the first team; **Phyl** and **Don Severance** will be cruising the Greek islands in mid-May and will stop in Istanbul armed with four possible spellings of Muradogla. Other travelers include **John Craig** in England and **Bill Shamban** and **Sol Kaufman** in Europe and Israel. . . . **Fred Kolb** has been attending technical conferences and voices an age-old observation in a new way about the younger generation: "They believe the world began yesterday—and it can be completely described in Quick Basic without the need for experimental data." . . . Our congratulations to **Muriel** and **Jack Wilber** on 50 years of marriage. I think they're the first—if not, write in.

Carol and **Al Wilson** could not make our mini-reunion in June because they were attending **Carol's** 50th at Wellesley. We admire Al's perspicacity in picking a '39er instead of a '38er. Eight of us made that sad mistake—**Brownie Wheeler** and **Bob Eddy**, **Miggie Blake** and **Lloyd Ewing**, **Helen Meyer** and **Wes Gwatkin**, **Hilly Morrison** and **Newt Hammond**, **Barbara Levy** and **Les Hornblith**, **Louise McKinney** and **Ira Lohman**, **Evey Robinson** and **Chip Parish**, and the **Hadleys**. Every five years we have to choose between Wellesley and the Institute and on the 25th, 40th, and 50th we had to double-dip into the family exchequer. The only excuses for such stupidity are abiding love, a lasting friendship, and a desire to make children together.

Somewhere in the transcription of the May/June notes **Korky Kaulakis** was moved from the garden spot of Chatham, N.J., to the dreary dunes of Chatham, Mass. Our abject apology to **Kroky** for the error.

The July notes reported the death of **Peter de Florez** and promised his many friends more about Peter in this issue. For those who knew Peter, his response to our 50th reunion questionnaire spoke volumes. His view of the most important challenge facing today's graduates: "Keeping a sense of humor." His guiding philosophy: "One day at a time."

Peter came naturally by his sense of humor. His father, **Admiral Luis de Florez**, '11, was a colorful officer, pilot and entrepreneur who taught his son to fly before most of us had reached junior high. **Jim Killian** in his book, *The Education of a College President*, described Luis as "an imaginative and charismatic naval officer." Classmates will recall how father and son, both members of the Number 6 Club (Delta Psi), made national news when Peter and his closest friend and classmate, **Cornelius Roosevelt**, were caught shooting an air pistol from the Number 6 Club. In the ensuing hearing **Admiral de Florez** served as a defense witness, baring his chest and demanding that the prosecuting attorney shoot the air pistol at him to show how harmless this "lethal" weapon really was. The charges were dismissed, and **Lowell Thomas** made quite a story about it on the national networks.

During the past four or five years Peter added a

serious dimension to his sense of humor. He was a far more reserved person than the above would lead one to believe—for example, resisting fundraising appeals as an intrusion on his privacy. But with the approach of our 50th Reunion Gift, Peter concluded he could be intrigued by the idea of establishing a Professorship in Humor, because he felt there was so little humor at MIT during his student years. Did he really believe in this or was it to "tweak" MIT just a bit?

Actually it was probably both. He did keep MIT guessing for three years. Yes, he was serious about his humor. Peter's mark will be left on MIT in a unique way. Eventually the bulk of his considerable estate comes to MIT. Part is added to his father's fund for awards for "outstanding ingenuity and creative judgement." He stipulated a major part should be for the establishment of a professorship in an area of MIT's choosing. As well as providing for a professorship, Peter created an endowed fund to support and promote activities related to humor at MIT. This fund, which will provide for lectures, prizes, and other activities, seeks to remind students of the importance of humor in all aspects of life, both personal and professional.

A decade before entering MIT Peter had an unsuccessful leg operation that dogged him the rest of his life. As a consequence, in the recent past he became increasingly immobile and was constantly in severe pain—undergoing numerous operations here and in Europe, Russia, or any place that offered hope. So he came to take "one day at a time." It's mighty hard to think about humor when you're feeling rotten. That he could is a real testimony to his spirit.

Peter was brilliant, straight-from-the-hip individual, particularly knowledgeable in the design and fabrication of special automatic machines and devices. Following graduation he first worked for a number of years in the aircraft industry and then moved to the engineering department at **Douleday** to design a modern high-speed plant in Hanover, Pa. Upon leaving **Douleday**, he rejoined his father's company, the **de Florez Company**, which specialized in book manufacturing machinery. The company became one of the best-known book binding machinery companies, and Peter was considered a noted authority in that area. He later sold the company to **Miehle-Goss Dexter, Inc.**

One of Peter's great joys was travel, and he never stopped in spite of increasing difficulties with his health. For years he travelled extensively to Europe on business, and with **Corny** to the Caribbean and Red Sea for scuba diving and underwater photography, at which he was truly expert. When forced to give up scuba diving, he and **Corny** took to hot air ballooning in France. By 1986 even this, too, had become impossible. Other trips from his home base in San Francisco included cruises through the Scandinavian fjords and traveling in Mexico.

When you read about the Smoot marks on Harvard Bridge and MIT student pranks like the balloon popping out of the ground at the fifty yard line at the Harvard-Yale Game—just think, somewhere some MIT students are plotting to get the **Peter de Florez** prize for innovative humor.—**Don Severance**, Secretary, 39 Hampshire Rd., Wellesley Hills, MA 02181; **Ed Hadley**, Assistant Secretary, 50 Spofford Rd., Boxford, MA 01921

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Mike Herasimchuk reports achievements by **Roy D. Haworth, Jr.** "Roy developed an abrasion-testing machine which showed clearly the supreme abrasion-resistant alloy is sintered tungsten carbide. Then Roy pioneered its use for edging mullers and mixing plows in foundries and sintering plants. Economic gain: 10 times the life for parts edged with the best hard-surfacing alloys."

Further on the subject of achievements: **Jim Barton** said more than three-fourths of our class-

mates contributed or pledged more than \$5 million as early as a month before its presentation as our Class Gift on Class Day 1989.

Bill Wingard continues to operate his machine shop in Baltimore and says he has a kindred spirit in **Rocky Roberts** who continues to publish books in Fitzwilliam, N.H. . . . **Manning Morrill's** cheerleading notes are newsy, stimulating, and reminiscence-provoking.

We are saddened by news of the deaths of three classmates: The *Boston Globe* reported the death, on March 25, 1989, of **King Cummings**. King served as president of Guilford Industries, manufacturing textiles in Maine. He was responsible for reorganizing Sugarloaf Mountain Corp. and he gave generously of his time, talents, and worth to Carrabassett Valley Academy, Maine Community Foundation, Skowhegan School of Painting and Sculpture, Colby College, Maine Maritime Academy, and MIT. . . . **Pete Bernays** reports the death on March 25, 1989, at Downers Grove, Ill., of **John Stiff**. . . . **Manning Morrill** reports the death, on February 3, 1989, of **Clark E. Taylor, Jr.** There were no details.—**Hal Seykota**, Secretary, 1701 Weatherswood Dr., NW, Gig Harbor, WA 98335

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50th Reunion

Recently, **Sybil** and I had the pleasure of having lunch with **Rhoda** and **Amos Joel** of South Orange, N.J. **Amos** told me of his selection as one of New Jersey's Inventors of the Year. The letter from the New Jersey Inventors Congress and Hall of Fame states, "These annual awards will be presented to New Jersey inventors holding unexpired patents, in recognition of their contribution to the progress of science and the welfare of mankind." The associated newspaper article noted, "Amos Joel participated in the development of the electronic switching system at AT&T Bell Laboratories, revolutionizing the handling of operator-assisted telephone calls and mobile telephones." The hall of fame was recently established by the New Jersey Institute of Technology. AT&T Bell Laboratories in Murray Hill is the first corporate member. Enrolled are famous inventors from New Jersey's past. These include: **Seth Boyden**, **Thomas Edison**, **Albert Einstein**, **John Stevens**, **Alfred Vail**, **Selman Waksman** and **Vladimir Zworykin**. The Inventor of the Year citations were presented at an award banquet on February 10, 1989. Congratulations, Joel!

By now, most of you will have heard from **Richard Babish** of Wilton, Conn., the newly appointed chairman of the 50th reunion. Beginning with the July issue of *Technology Review*, all known class members are being sent copies in honor of the reunion. Please note that we will meet at the Mystic (Conn.) Hilton Hotel from June 4 to June 6, 1990. We will then return to Cambridge, to continue with Red Jacket festivities at the Boston Pops, marching in the commencement parade, and Alumni Day activities. At that time, our Class Gift will be announced. It is the goal to have participation in the Gift by 100 percent of the class members. Let's all do our part, and exceed the goal that has been set! As of late April 1989, 113 classmates have said they plan to come to the reunion, with 25 "maybe's." It looks like a gala celebration.

To continue with some of the comments that have come with returned reunion questionnaires: **George Kaneb** of Massena, N.Y., writes, "I have kept in touch with **Beano Goodman** and **Dick Braunlich**, seeing them each winter, playing tennis, listening to all the ailments, and enjoying semi retirement." . . . From **Richland, Wash.**, **Raymond Keyes** notes, "Virginia and I still reside in our home of 21 years on the banks of the Yakima River. When it dropped to below 0 degrees F., we warmed up with a trip to Florida. We enjoyed Epcot, the Magic Kingdom, Cypress Gardens and a couple of dinner show attractions." . . . **John C. Klock** writes from Baton Rouge, La.; "Now retired—traveling—playing golf still, but not the

same as when I was at MIT; three children and seven grandchildren." . . . **Kenneth Lish** lives in Woodmere, N.Y. He says, "I tried retiring in 1982. It lasted three months, and I couldn't stand it. I'm now an engineer with very few responsibilities at Shoreham Nuclear Power Station. Oh, yes. I wrote a book on nuclear plant equipment in 1972."

You have probably already heard from **Tyler Marcy** of E. Dennis, Mass. He writes, "I've been tapped to be chairman of your class's 50th Reunion Gift Committee of 23 classmates. I am also current president of MIT Club of Cape Cod. Still consulting on management and computer technology issues." . . . **Marshall D. McCuen** writes from Indianapolis, Ind., "We celebrated our 50th wedding anniversary in December with a Caribbean cruise with our four sons and their wives. When I read about **Beano Goodman's** one hip replacement, I sent him a note about my having both hip joints replaced four years ago. I read in the class notes about classmates volunteering as SCORE counselors. I just want to say I have been a SCORE counselor since I retired from GM eleven years ago, and was manager one year. It is a great thing to volunteer for." **Edgar Bernard** and I are both SCORE counselors in the Boston chapter. It is great fun, and very rewarding, because we know we are helping people. In addition, I serve as an arbitrator for the American Arbitration Association. That has been a wonderful experience. Has anyone else tried that?

John M. McKee, Jr. retired from Argonne National Laboratories in 1985. He writes from Hinsdale, Ill., "I will do a little consulting work at the Lab this year. We took three long driving trips in 1988 visiting friends and family coast to coast. Now looking for a retirement site in southern California where I can do some rowing." . . . **Louis Michelson** of Newton, Mass., spends the winters skiing and the summers gardening, swimming, bicycling and reading. . . . From Sewanee, Tenn., **Arnold L. Mignery** notes that he retired as a silviculturist. He specialized in the regeneration of Appalachian mountain hard wood forests. Do we have any other silviculturists? . . . **Ralph T. Millet** writes from Old Saybrook, Conn., "I retired from SAAB in September 1987 after 35 years representing that company in the United States. I bought a small export company called DFL, Inc., in New Haven, Conn., in 1985 and am still going strong running that business." . . . **James H. Moore** of Gilford, N.H., says, "In fifth year of retirement. Have been serving on legislative advisory commission on nuclear waste; chairman of North Country Resources Conservation & Development, Inc.; Director, Lakes Region Federation, Inc.; and volunteer consulting with non-profits on computer use."

From Sharon, Mass., **Saul Namyet** writes, "Sylvia and I retired in August 1986. I most recently served as acting dean of engineering at Northeastern University. Now enjoying retirement working with local Council of Aging to help less healthy seniors in a variety of ways. We travel as frequently as possible with recent trips to southwest national parks, Spain, and next to Canadian glacier country." . . . **Fred F. Noonan** of Hillsborough, Calif., says, "I am still actively involved in my own business, Fred F. Noonan Co., Inc., which is involved in ship agency work, brokerage, marine terminal operations and stevedoring. Still married (46 years); three children, five grandchildren." . . . **Eleanor A.** (Mrs. Albert F.) **Norris** of Norwell, Mass., writes that she is retired elementary school and piano teacher. In 1970, she gave 100 acres of land on the North River in Norwell to the Trustees of Reservations in memory of her husband. Her latest travel tour was to all three islands of New Zealand to look up relatives of her husband, who had settled there in 1880. . . . **Rowland Peak** is still consulting in Metairie, La., but he is getting very picky about what jobs he takes. He hopes to be a great grandfather this summer! . . . From Darien, Conn., **Frank Penn** writes, "Fully retired from business, but currently chairman of planning and

zoning commission, and into sixth year of service. No recent direct contact with classmates. Two single daughters, one into sailing and the other horses. Married son is controller/treasurer for Hartford architectural firm."

There are still more responses, which will be in the next issue. I welcome notes from all of you, but especially from those who are receiving *Technology Review* for the first time.—**Richard E. Gladstone**, Secretary, 1208 Greendale Ave., Needham, MA 02192, (617) 449-2421

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William K. Hooper tells us that there will be a centennial celebration of Phi Gamma Delta, 100 years of the fraternity at MIT. He sees many fraternity brothers every year. The house at Fenway is still there. Bill promises to send a full report about class of '41 attendees.

Stewart E. Miller, a Bellcore consultant and a former director of lightwave telecommunication research at AT&T Bell Lab, won the John Tyndall Award for distinguished contributions to fiber optics. He is cited for foresight, dedication, technical contributions, and pioneering leadership in building the broad foundations for today's fiber optics telecommunications systems.

Stewart was instrumental in establishing the first conference on optical fiber communications (OFC) in 1975. He originally proposed the integration of several optical waveguide functions on a single substrate, coining the expression "integrated optics." He also first proposed and participated in the demonstration of single material optical fibers that achieved single mode and multimode waveguiding through transverse geometrical non-uniformity of the dielectrical material. He joined the technical staff of AT&T Bell Lab in 1941 after receiving his S.M. and S.B. degrees in electrical engineering.

Other honors include IEEE's Morris N. Liebman Award in 1972 and its W.R.B. Baker prize in 1975, as well as the Stuart Ballentine medal from the Franklin Institute in 1977. He is a member of the National Academy of Engineering and a fellow of OSA, IEEE, and AAAS. Quite a record!—**Joseph E. Dietzgen**, Secretary, Box 790, Cotuit, MA 02635

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The travelling **Bernard Leveres** visited King George Island in Antarctica in 1987; toured eastern Turkey and cruised Mexico, the Panama Canal and Hawaii in 1988. Plan to tour New Guinea, for the second time, this year.

Closer to home, Jean and I with Eleanor and **Walt Eberhard**, Hazel and **Fred Gander** and Bea and **Dick Andrews** had a Class of '42 luncheon in Sarasota, Fla. Walt is active in the MIT Club of SW Florida; Fred and Hazel's oldest grandchild graduates from Amherst in May and Dick Andrews is still fishing, hunting, and fixin' things, not necessarily in that order!

The only news from Cambridge is that **Bob Seamans** who got his SM in Course XVI with us, was elected a member emeritus of the MIT Corporation. Former Secretary of the Air Force, he continues as senior lecturer in the department of aeronautics and astronautics.—**Ken Rosett**, Secretary, 191 Albemarle Rd., White Plains, NY 10605

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Just before I wrote these notes, the 45th reunion committee held its last meeting to wind up the long, and at times complicated, planning necessary for a successful time. Present were Jane and **Louis Demarkles**, **Les Brindis**, **Stan Warsaw**, **Melissa Teixeira**, **Jim Baird**, **Julie** and **Bob Smith**, **Janice Kispert**, and **Ruth** and **Norm Sebell**. We hope that the planning resulted in an enjoyable time for all who attended the reunion. We also hope that your appetites are whetted for an even

bigger and better 50th reunion.

Alan Rose writes us that his patent law work exposes him to the latest technological developments. He thinks that more MIT people with communication aptitude or skills should consider patent law as a career.

We have received further information on the Reverend **Roland Benjamin**, whose death we noted in the July notes. He served in the army at Aberdeen Proving Grounds during World War II. After the war he was a consultant to manufacturing companies, and earned a master's degree in business administration at Columbia University before beginning his studies at the General Theological Seminary in New York City. He was ordained in 1961 and served full time in the ministry before joining the J.C. Penney Co. as catalog marketing manager, while continuing part time in the ministry. He retired from Penney about seven years ago and moved to Florida. He died of heart failure.

We are saddened to report the death of **Chet Woodworth** in February. Chet was very active in Institute affairs. He served on the Alumni Advisory Council and was president of the MIT Club of the Connecticut Valley. We recall with fondness how well and how hard he and Doris worked on various reunion committees, including the 45th. Chet was employed for 38 years by Monsanto, where he specialized in extrusion technology, a field in which he published widely and held several patents and many patent disclosures. In 1984 he received the Best Paper of the Year award at the annual Technology and Extrusion Conference. He worked much of the time with the overseas operations of Monsanto, and was especially involved with the design and expansion of an extrusion plant in Ghent, Belgium. Those of us who knew him will remember his avid interest in tennis and sailing, including a famous voyage with three others from Bermuda to Boston. He was, indeed, a gentle man and we will miss him. Our deep sympathy goes to his wife, Doris, his daughter, Ann, and the other survivors.—**Co-Secretaries: Andrew Corry**, P.O. Box 310, W. Hyannisport, MA 02672; **Lou Demarkles**, 53 Maugus Hill Rd., Wellesley, MA 02181

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Checking back through my archives I can't find any previous mention of our senior class president, **Herb Hansell**. After a brief stay in the U.S. Naval Reserve, Herb entered Yale to study law, and got his LLB in February, 1949. After working in New York City and Washington, D.C., he joined Jones, Day, Reavis & Pogue in Cleveland. In 1977, he moved back to D.C. to become law adviser to Secretary of State Cyrus Vance. Herb was involved in major diplomatic negotiations, including the Panama Canal Treaty, the Egyptian-Israeli Peace Treaty, establishing relations with the PRC, and the SALT treaty; in 1980 he was ambassador and senior adviser on the U.S. delegation to Mideast peace negotiations. Since then he's returned to private practice with his former firm, where he specializes in international commercial law. His wife of 38 years, Jeanne, is a psychotherapist and published poet. One son is a lawyer in New York City, another son is a clinical psychologist, and a daughter is director of development and alumni affairs at Temple Law School. Herb keeps busy with civic and alumni activities, and he expects "to go on enjoying what we're doing."

Ted Henning prepped at Adelphi and went along with **Bob Spoerl** and **Ray Brown** to Columbia for his MBA. He was with Westinghouse for a few years before the Navy called him back for the Korean flap, only to ship him out to the Mediterranean on the carrier Midway. Two years later he returned to Brooklyn to join Belmont Metals, which develops non-ferrous metals from which they produce perhaps the nation's largest number of applications. He and Margie live in Manhasset, where his avocation is the educational field (such as Tech's Educational Council). They enjoy sailing

in nearby Long Island Sound and skiing. They have three children, two of whom have been or are going to Dartmouth.

Ralph Huschke is in "the forensic field of weather investigations and expert testimony," out of his own consulting shop. Ralph, always an avid boat man, stayed with the U.S. Naval Reserve more than 20 years, doing all kinds of meteorological wizardry, including some time with MIT, the Weather Bureau, and Navy tours, flying through hurricanes and "cruising" to Antarctica. He went west in 1959, first with Northrop and then to Rand, where he's dealt mainly in weather effects on military systems. He and Ginnie have lived in Coronado for quite a spell. Their "toys" include: a boat (at the back door), a motor home, and a condo in Guaymas. . . . Another boat person is **John High**, who plotted a similar course, opting to remain in the Navy until he retired as commander in 1970. John applied his lore to Naval ordnance systems, mostly missiles (such as Polaris), during tours in a variety of places from coast to coast plus Hawaii, settling finally in Arcadia, northeast of Los Angeles. Along the way he got married (two months after graduation), sired two girls, did time in an oil-well instrumentation company, took a hike, remarried, and took up flying. . . . An apology to **Bob Fagot** for my typo in the June issue, having him teaching at Oregon University for 30 years until retirement in 1968. Needless to say, that should have been 1986.—**Jim Ray**, Secretary, 2520 S. Ivanhoe Pl., Denver, CO 80222

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We have news this month of three classmates honored by various professional societies—we'll report in alphabetical order!

Harl Aldrich has been named an honorary member of the American Society of Civil Engineers (ASCE)—the most prestigious honor bestowed by members of the civil engineering profession on their peers. Harl was cited for his contributions to the profession through teaching, development of state-of-the-art applications, and involvement in professional societies and educational institutions. He is the author of over 30 professional papers and journal articles on subjects ranging from frost penetration to vertical sand drains. He is a past president of the Boston Society of Civil Engineers and has received that group's Ralph W. Horne Award for unpaid service to the Boston community. Harl is a cofounding principal of the Boston consulting firm of Haley & Aldrich, Inc.

Bob Balluffi recently received the 1989 David Adler Lectureship Award from the American Physical Society. The citation read: "For his seminal experimental and analytical contributions, which have clarified our fundamental understanding of the atomic mechanisms of sintering, Kirkendall phenomena, dislocation climb, solid-state diffusion, the production and recovery of radiation damage, grain boundary structure and energetics in metals and ceramics; and his accompanying lucid writing and verbal skills in presenting these investigations." (We are frankly most impressed by the last eleven words!)

Bob Rediker was recently elected a member of the National Academy of Engineering. Academy membership honors those who have made "important contributions to engineering theory and practice, including significant contributions to the literature of same," or those who have demonstrated "unusual accomplishment in new and developing fields of technology." Bob was honored for his work in constructing semiconductor compound light emitters and lasers. He is on the senior staff at Lincoln Labs and is also a senior research scientist at MIT.

Other news. **R. Langdon Wales** died in March. He was vice-president of Roll Space Systems, Inc., of Concord and president of Lincoln Technology, Inc., of Burlington. He had been active on many town boards and committees in Lincoln,

where he had lived for 30 years. He is survived by his wife, Ruth, of Lincoln; one son, three daughters, and one grandson. . . . Recently, our classmate **Moishe Arens** has been in the news almost every week. He is foreign minister of Israel. . . . **Art Schwartz** and his wife Margie have recently moved from Irvine, Calif., to Honolulu. Finally, our thanks to the following classmates who participated in a class telethon last spring: **Harl Aldrich, Claude Brenner, Virginia Grammer, Martin Haas, Bob Hagopian, John Murphy, Al Richardson, Hrand Safenian, and Parker Symmes.**—**Robert E. McBride**, Secretary, 1070 Pilgrim Parkway, Elm Grove, WI 53122

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Elliott Bates has retired and has lost his wife to Alzheimer's disease. He has been tutoring English as a second language. He has climbed many small mountains and traveled to Wales, Yorkshire, and New Zealand. . . . **Ezra Garforth** sold all of his Gingiss Formalwear stores last year. He continues as a consultant for Gingiss in South and North Carolina and Mississippi. He had a long career in metalworking prior to buying the stores; he was president of Philadelphia Steel and Wire Corp. and later executive vice-president of Central Screw Co. of Chicago. Currently, he is a counselor for Service Corps of Retired Executives (SCORE). His golf is improving.

A review of **Vaughn Beals'** career: he was at North American Aviation (Columbus Division) from 1955 to 1965. In his final position as division director for research and technology, Vaughn had responsibility for a 700-person organization. He went to Cummins Engine Co. (diesels) as vice-president for research and engineering and became executive vice-president and a director with worldwide responsibility for the engine business. The entrepreneurial phase of his career started when he became founder and partial owner of a company to manufacture mobile logging equipment, particleboard presses, and industrial cranes. He joined AMF in 1975 and in 1981 led a group of 13 officers and purchased Harley-Davidson from AMF. After a serious flirtation with financial disaster, Harley is a success—(NYSE/Fortune No.398) with a market share double that of their nearest competitor (Honda).

Vaughn and his wife, Eleanore, have two married daughters and five delightful grandchildren. . . . "**Doc**" **Bressler** completed 37 years of a rewarding and successful career working with General Electric's locomotive business where he managed the marketing, sales, and service for their mainline domestic locomotives. Since retiring in 1985, Doc and his wife, Dee, have done more cruising on their sailing auxiliary, more touring, and more visiting. He also spends more time at the piano, has joined the local SCORE chapter, and works with a group promoting boating safety. They moved from a five-bedroom house into a condo, but Doc was able to keep his shop and his model railroad in the basement of the condo. He uses his Tandy computer regularly. Their son is practicing neurosurgery in Green Bay, Wis. Their daughter lives in Erie, Pa. They have three grandchildren. . . . **Edward Eaker** has retired after 36 years of service with Long Island Lighting Co., where he was treasurer for the last 14 years. He has moved to Pisgah Forest, N.C. . . . **Al Fioravanti** has retired from active employment with the University of Rochester (NY). He is doing consulting with local firms on an "as I need them basis to keep my gray matter functioning." Al continues barbershop singing, chorus, and is doing volunteer work. He is active with ASHRAE locally and nationally and is finding this period to be the most enjoyable time of his life. Since 1983, Al and his wife, Anne, have been blessed with six grandchildren. If you are in Rochester, N.Y., they invite you to their home. . . . **Bill Cummings** retired from General Motors in 1983. He has concluded business relationships with his two brothers and has sold the remaining operat-

ing businesses. He resigned from all civic responsibilities and now spends most of the year in Bonita Springs, Fla. Other stops include a New Hampshire lake, visits to their Michigan home, antique car groups, and tours. He and his wife, Barbara, play golf and tennis regularly. . . . **Tom Folger** retired from Kidder Peabody in 1983 after 24 years with the firm. He and two associates raised \$50 million for a venture capital fund late in 1983. The climate for technology investments since then has been less than hospitable. Fortunately, they have some up-and-coming companies in their portfolio that promise to be of value. However, the whole process has not been an easy street in the last five years. A number of MIT alumni are either heading companies or guiding the technological progress of some of the firms in their portfolio. With that kind of leadership, how can we fail?

Tom's daughter is a junior at Wellesley. Her activities and Tom's visits to the campus bring back many happy memories of connections to Wellesley when he was struggling to get through MIT. His daughter was fascinated by an architecture course she took at MIT this past year. His son is a junior in high school and is leaning toward a technical education. Their family enjoys watching the grass and trees, which are relentlessly growing at their farm in Waitsfield, Vt.

John Little was elected to the National Academy of Engineering. He was recognized for his leadership and outstanding contributions to operational systems engineering including research, education, and applications in industry.

George Cooper died two years ago. He served in the Navy during World War II and the Korean War. His career included the insurance and commodities trading businesses. He was president and co-founder of Dungarvon Corp. in New Scotland, N.Y.

Nancy and **Don Noble's** daughter, Pam, died in April. Pam had graduated from Yale Divinity School and then received a degree in psychology from Columbia. Pam had been counseling patients in Washington, D.C., for several years. She was well known for her quest to understand an individual's relationship with God. She was a gifted counselor helping patients, family, and friends. Pam's roommate at Yale, who is now a minister, gave a eulogy at the funeral service. Pam was a vivacious woman who enjoyed liturgical dancing, intellectual studies, and had a marvelous capacity to understand those around her. During the last months of her life, she agreed to many treatments hoping to control the cancer in her body. She never lost her faith and did not admit to physical pain. She was distressed by having to leave so much of God's work undone.

On behalf of our classmates, I extend our sympathy to the families and friends of those who have died.—**Marty Billett**, Secretary, 16 Greenwood Ave., Barrington, RI 02806

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40th Reunion

By the time you read this, it will be less than a year to our 40th reunion. In April, a few of your classmates joined to prepare for the reunion. **Bob Cesari** consented to accept the position of reunion chairman and has begun assembling a committee. If you wish to help, please contact Bob or me. Activities are scheduled to begin with "Tech Night at Pops," June 7, 1990. The following day will be the traditional meeting of the Alumni Association. The present plan is to hold a class banquet at the Museum of Science on Friday evening. For those who wish, a three-day off-campus reunion will follow at a location in New England still to be chosen. Additional information will be forthcoming. Please remember to save the period from June 7-12. We hope that many will attend this reunion. If you have not returned to MIT for years, you'll find that many changes have taken place in Cambridge. We look forward to seeing you again.

Frederick Sadri, a principal with Odell Associates, Inc., architectural and engineering firm in Charlotte, N.C., has recently retired after 20 years of service. . . . Your secretary retired July 1, 1989, from Eastern Gas and Fuel Associates after almost 39 years with Eastern and its subsidiary company, Boston Gas. I am involved in environmental consulting but will have more time for golf and fishing on Cape Cod.—**John T. McKenna**, Secretary, 9 Hawthorne Pl., Unit 10-H, Boston, MA 02114

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Although it required the taking of retirement from GE Major Appliance to do it, **Walter Johnson** writes of his breaking 80 in golf for the first time. Walter retired in March 1988 and achieved his major golf goal three months later. He is enjoying his retirement immensely, and we hope to hear of his breaking into the low 70s soon.

Unfortunately, I have to relate the passing of another of our classmates. **Ernest E. Jensen** of Jacksonville, Fla., passed away on March 1, 1988. We wish to relate our condolences to his wife, Lucy, and to his family.—**Martin N. Greenfield**, Secretary, 25 Darrell Dr., Randolph, MA 02368

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I have mentioned before that **Burt Richter's** activities are often news in the local paper here. For example, last April an article illustrated with a color photograph was on the front page. The caption describes it: "Nobel Prize-winning physicist Burton Richter climbs a table in Menlo Park." The San Jose paper waited until the weekend to carry the story, with the caption, "Burton Richter stands on a picnic table." It looks as if he was standing there for some time: one picture showed him wearing a jacket, and the other has him in shirt sleeves. Burt, as director of the Stanford Linear Accelerator Center, chose the picnic table as a platform to announce that the center had produced its first Z particle. They had hoped to produce them in large number, but Z particle production, done by colliding a high-energy beam of electrons with a similar one of protons, proved more difficult than had been hoped. The task was reorganized and efforts were redoubled, finally achieving a degree of success justifying a press conference and a celebration.

Another physicist classmate also deserves congratulation. **Bob Ely** has been elected a fellow of the American Physical Society "for contributions in particle physics to the understanding of the baryon multiplets and investigations of the properties of quark partons." Bob is at the University of California, Berkeley.

The Society of Automotive Engineers has elected **William B. Smyth** a fellow for his contributions to the technology of heavy duty trucks. Smyth is an engineering consultant for Daimler-Benz.—**Richard F. Lacey**, Secretary, 2340 Cowper St., Palo Alto, CA 94301

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There haven't been many items since last time. Therefore, I reached back in the files and pulled out some of the more recent ones. This is a hint to you all to sit down and write to me so I have some new and interesting material to report. I might even reach that terrible state of not having any news and have to resort to relating tales of my exciting activities.

Purdue University reported that **Louis Branges**, a professor of mathematics, has been named the first Edward C. Elliot Distinguished Professor of Mathematics. Kenneth L. Kliever, Dean of Purdue's School of Science, said that "Louis Branges has solved problems that have defied generations of determined mathematicians, thereby placing himself in the vanguard of the world's mathemat-

ics community." Congratulations Louis. . . . **Wally Reid** reports that he is semi-retired while continuing to perform services as an independent designer and appraiser. He is also a former innkeeper and a retired Air Force pilot (I can certainly empathize with that). He plans extensive travel in the future. He reports that he has 11 grandchildren. . . . **Mort Friedenthal** has been with TRW for over 31 years. He is currently program manager for Space Station Activities on Platforms and Servicing. His wife, Jane, is a part-time reference librarian at Pepperdine University. His sons Robert (24) and Mark (22) are finally out on their own.

Flo Miraldi is director of nuclear radiology and director of the positron facility at University Hospitals of Case Western Reserve University in Cleveland. He says that he is having a great time combining engineering and medicine, but he is looking forward to retirement in a few years. He plans to continue consulting in medical engineering part-time as he eases into retirement. . . . **Marvin Turkanis**, vice-president of Neutron Products, Inc., has developed techniques for marketing capital items by a combination of mail, telephone and commercial exhibits. He has captured 50 percent of the domestic market and is expanding internationally. He is looking for other products for which the technique would be effective.

That about wraps it up for this month. Remember, take some time to sit down and drop me a line.—**Gilbert D. Gardner**, Secretary, 1200 Trinity Dr., Alexandria, VA 22314, (703) 461-0331

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You should have your reunion questionnaire by now, listing the spectacular options which **Joe Saliba** has aptly named "Classic '55," "Historic Boston," and two flavors of extended reunion—"Historic Boston plus Extended Classic '55" and "Historic Boston plus Bermuda." They all sound wonderful to Edie and me. We await your vote so the committee can make the big decision and get on with detailed final planning. If you have put that questionnaire aside, please find it, decide to come, and tell us which option you prefer. If you did not receive the mailing, give me a call and we'll send you another one.

One enormous source of news for class secretaries is the reunion: mailings, planning sessions, and of course the reunion itself. We hit a dry spell this month, but with your help we look forward to great quantities of reportable news in the coming months. . . . Jan and Ed Ehrlick report that their daughter, Karen, graduated in May from Columbia: liberal arts with a history concentration. She plans to work in New York in the public relations field. . . . Please keep the news coming.—**Robert P. Greene**, Co-Secretary, 100 Memorial Dr., Apt. 11-2A, Cambridge, MA 02142; **DuWayne J. Peterson, Jr.**, Co-Secretary, 201 E. 79th St., New York, NY 10021

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About 40 classmates, spouses, and friends got together in April at MIT to meet and talk with Professor Hastings of the Department of Aeronautics and Astronautics, the current holder of the Career Development Professorship established by our class gift. Discussions with Daniel Hastings proved interesting and stimulating. Our gift has allowed Daniel to make more efficient use of time and effort in his teaching, advising, direction of programs, performing research, and taking part in other areas of interest through the purchase of computer equipment and the hiring of a research assistant. It proved of interest to find that Daniel was born in 1956. This mini-reunion provided those in attendance with a first-hand opportunity to appreciate the benefits our gift provided to MIT, to Professor Hastings, and to his areas of activities.

John N. Newman, professor of naval architecture, MIT, was elected to the National Academy of Engineering for outstanding contributions to theoretical and applied hydrodynamics of ships and ocean structures. . . . **Howard Alan Trachtenberg's** wife Carol has stopped working and is going to Mt. Holyoke College part-time. Daughters Melaine and Fay are both married and both have a son. Howard's son, David, graduated from U Penn (Wharton and Lander Institute) and is working for Bain & Co. in Paris. Howard is chairman of the Department of Anesthesiology at Baystate Medical Center in Springfield, Mass., a teaching hospital of Tufts School of Medicine. Howie and Carol spend as much time as possible at their home in Vermont where he is on a ski patrol and plays golf during the summer. . . . **James Olaf Stenberg** is retired after 30 years with Monsanto. He lives in the mountains of Arizona and does tax consulting in the spring. Interests include two grandchildren, traveling (Hong Kong, 1988), horse back riding, and gardening.

Gerald Charles Sozio has enjoyed the last 12 years as a coach, referee, and commissioner with the American Youth Soccer Association. The whole family has benefited socially and physically from their participation. . . . **Norman Siegler** moved to California to join a start-up company dedicated to the design and recently the commencement of commercial shipment of an \$80,000 graphics supercomputer, 64 bit, 64 MFlop, 64 MIP device with tightly integrated graphics. . . . **John Adam Seeger** is a full professor as predicted by Edwin Shell in 1957. John started delivering papers in Detroit as a fourth grade student. He still delivers papers as a professor but in different places: Barcelona, Singapore, Sao Paulo, and Buenos Aires. Academic life has a few advantages. John remains involved with the Kappa Sigma Fraternity International Organization. . . . **Hermenegildo Rosales Y. Manosa** is looking for better job prospects and is interested in facilities and connections that we and MIT may have.—Co-Secretaries: **George H. Brattin**, 39 Bartlet St., Andover, MA 01810, (508) 470-2730; **Irwin C. Gross**, Sweets McGraw-Hill, 1221 Ave. of the Americas, New York, NY 10021, (212) 512-3181

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Still more 30th reunion news! We talked with Helen and **Gus Fleisher**, whom we had not seen since the previous reunion. Gus is now a project manager with the civil engineering firm of Schiavone Construction Co. This firm does major construction projects, primarily on large tunnels, subways, water and sewage treatment facilities. Currently, Gus is working on a sewage treatment plant project in Manhattan. At the same time, he serves on the board of advisors at New Jersey Institute of Technology where he is an adjunct professor in civil engineering. Gus is a member of the "Moles," an honorary society for individuals involved in building tunnels, as well as a member of the British Tunneling Society. Gus and Helen have two daughters who are now gone from the nest. . . . **Joe Mulloney** is now with the consulting firm of EA Engineering Science and Technology, Inc., which employs about 350 people. The basic focus of this company is small scale co-generation projects. Previously, Joe had been with Falstaff-Carling Breweries for 15 years in the Boston area. As reported earlier, Joe and his wife, Judy, now have a year-old son.

Both **Jim Galbraith** and his wife, Barbara, are employed by Mobil Oil in Dallas. Jim graduated in Course XII and also holds a PhD. He joined Geoscience, Inc., as a staff scientist in 1973. In 1969, he joined Mobil Research Laboratories and first worked in operations developing algorithms for seismic data processing. Later, he moved into management and was in charge of geophysical operations in new areas, particularly oil concessions in Africa and other developing countries. Currently, he is manager of the Geophysical Ap-

plications Group that performs the seismic processing for all of Mobil's exploration and production operations. Barbara is manager of Client Services for Mobil's Technical Computing Center in Dallas. . . . Also at the reunion, **Herb Johnson** told us that he is now senior environment council for the National Association of Attorney Generals in Washington, D.C. His primary responsibility is to provide information to the Attorney General in each state on such environmental issues as the "Super Fund" hazardous waste activities, Department of Energy Operations, and environmental hazards and compliance requirements. Herb and his staff also publish a regular journal and conduct training programs for state officials regarding environmental issues. Herb attended the reunion with his friend, Delia O'Hara, who is also an attorney, but with the Bureau of Competition of the Federal Trade Commission. They have recently bought a house together in Washington and are busy restoring it. They said with humor that in their case the "tie that binds" is a mortgage! . . . **Willy Sander** has been director of Engineering at Dichtaphone Co. in Stratford, Conn., for the past 16 years. Prior to that, he spent three years at Technicon, a manufacturer of blood monitoring instruments, and before that was at CBS Laboratories as a project engineer. Willy has also been very active for many years with the Boy Scouts in Connecticut and serves as a council chairman. Willy and Carol have a son, who is an Eagle Scout. They have also been involved in the "Safe Ride" program in their area.

Our class is sorry to learn that **Michael "Spike" Miller**, M.D., professor and former chairman of the Department of Pediatrics, School of Medicine, University of California, Davis, died in January of a heart attack. He had received a heart transplant in July 1987 at Pacific Presbyterian Medical Center in San Francisco. As a pediatric immunologist, he was internationally known for his work on Leiner's disease and leukocyte function, and for helping build one of the first computerized intravital microscopes. Our class extends sympathy to his wife, Paula, and their four children. He will be greatly missed, but his contributions to the advancement of medical science provide a wonderful legacy for us all. . . . We'll see you next month.—**Mike Brose**, Secretary, 841 Magdeline Dr., Madison, WI 53704

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Well, this is a surprise. When Art and I said good-bye a month or two ago, we were premature. This brief column is being written several weeks before the reunion, where we will pass the baton on to one or more of you.

The news. Earlier this year, **John J. Henry** was elected to become a national director of the ASTM. John is a professor of mechanical engineering and director of the Pennsylvania Transportation Institute at Penn State. . . . And from Course IV, **Robert E. Schofield** has been elected a fellow of the American Physical Society. In the Division of History of Physics, Bob's citation read as follows: "for his research in the history of physical science, especially the works of Joseph Priestly and 18th century natural philosophy." Congratulations to you both.—**Ron Stone**, Secretary, 116 Highgate Place, Ithaca, NY 14850, (607) 257-2249

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30th Reunion

Good news comes from the president of the National Academy of Engineering, who announced that two classmates, **Ronald Rohrer** and **Jerry Woodall**, were elected to that prestigious group. Ron is a professor of electrical and computer engineering at Carnegie Mellon University and was honored for his "creative contributions to simulation strategies for computer-aided design and for leadership in electrical engineering education." Jerry, who is a fellow and manager at IBM's Tho-

mas J. Watson Research Center in Yorktown, N.Y., was cited for "outstanding contributions to the preparation of compound semiconductor structures and devices for high-speed and optoelectronic applications." In a separate announcement Jerry also was named by the Intellectual Property Owners Foundation as one of the 20 finalists for the 1989 Inventor of the Year award. Jerry's nomination was based on his innovations in the field of semiconductors and related materials for integrated circuits, optical devices, and energy conversion. Congratulations Ron and Jerry! . . . A short message from **Hugh Morrow** noted that he is living in Greenwich, Conn., and is the executive director of Cadmium Council, Inc.

Personal news from your secretary shows that laboring on behalf of Tech, in this case serving on the Washington, D.C., committee of the Campaign for the Future, can bring unexpected benefits. In November 1986, Marie O'Connor, MIT's District Director for Washington, asked me to consider serving on the Campaign committee. I accepted the invitation. In November 1988, Marie and I were engaged, and on May 7, 1989, we were married in Buffalo, N.Y. We honeymooned in Spain and Portugal and are now living in Arlington, Va. Marie is executive director of the American Speech-Language-Hearing Foundation. While the Campaign lost its best district director (and I gained a beautiful bride), Marie remains a member of the MIT family. Finally, don't forget that it's countdown time for the 30th reunion—June 1990.—**Frank A. Tapparo**, Secretary and Class Agent, 15 S. Montague St., Arlington, VA 22204

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After a few weeks of speculation to the contrary it now appears that **John Sununu** is a success at the White House and will stay for the duration. It is still a bit of a shock to see a classmate on the nightly news. One would expect we will soon be gazing at John on the cover of a weekly news magazine.

Most of us are more prosaic. But for our class, prosaic is still pretty spectacular. **Marshall Green-span**, for example, writes that he was "promoted up the technical ladder to director of technology at Norden Systems Division of United Technologies. I am working on advanced technology airborne radar for the military. I have three children: Mannie, 20, who goes to Boston University; Howie, 17, accepted to Warton College at the University of Pennsylvania for the fall of 1989; and Shelly, 14, a freshman at Fairfield (Conn.) High. My wife Sheila, has her own business running arts and crafts parties."

Ed Berger, another example of what an MIT degree will get you, was elected the vice-chairman of the Particles and Fields Division of the American Physical Society. That means he did the work—he organized the invited papers for the recently completed APS national meeting in Baltimore. He says it's "a very exciting time in particle physics. There has been marvelous progress plus the exciting plans for the superconducting supercollider." Is Ed going to move from Downers Grove, Ill., to Waxahatchee, Tex.? . . . One of the items on business at the APS meeting was to install a bunch of new people of the society. Among the chosen was **Malvin Teich** who was cited for "seminal experimental and theoretical studies of the quantum nature of the detection and generation of light."

More honors! **Harold Bowers**, who runs the Hughes Aircraft Industrial Electronics Group was elected a fellow of the IEEE. He is looking very handsome, if the picture that came with the announcement can be believed. . . . I keep getting the most fascinating letters from **Bob Pease**. His book (actually a 250-page paper) on trouble shooting analogue circuits has been published as an exciting serial in EON magazine starting last January. This is how Dickens got his start, Bob. . . . Over at Purdue, **Frank Incropera** has been the



Harold Bowers, '61

head of mechanical engineering since last March. Purdue's dean of engineering said all sorts of nice things about Frank: "a strong leader, an outstanding teacher and a world class researcher of heat transfer." Not too shabby, Frank. Congratulations.

A release from Dow Chemical says that **Robert Andrews** is now the manager of financial planning for Dow's Plastics Group. That means he will be involved with strategy—a concept I am beginning to learn over at EG&G. . . . **Stan Park**, who was Course VI, was promoted by MITRE Corp. to an associate department head in Fort Monmouth, N.J. He has been all over the world for MITRE, including Heidelberg and Boston. . . . **Gerry Wilson**, dean of engineering at MIT, thinks that it's going to take more than four years to train engineers in the future. [Can't the professors just talk faster?] Gerry thinks U.S. engineering has two major problems. The first is simply generating competitive products. The second relates to the increasing conflict between technology and society in general. He doesn't know the answer to these problems but wants to start talking about their solution(s). If you have some ideas you could write to him at MIT (sending me a copy).

I'm sorry to have to report the death of **Nicholas Alter, Jr.**, Course I, January 23, 1989. Nick had a long career teaching computer science and establishing computer labs around the country and the world. In the U.S., he taught at Keane State College, N.H. and the University of New Hampshire. In Turkey he set up a department at Roberts College in Istanbul. A remarkable career. I know the class sends condolences to his mother and brother Theodore.—**Andrew Braun**, Secretary, 464 Heath St., Chestnut Hill, MA 02167

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A note from **Ronald R. Troutman** indicates that he was elected a fellow of the Institute of Electrical and Electronics Engineers (IEEE) effective January 1, 1989. Congratulations to Ron and our other classmates that have been similarly honored by their professional associations for contributions to their respective fields.

I noticed in the May *New York Times* that **John A. Rollwagon**, chairman of Cray Research, Inc., has stated that the is confident in the U.S. (and Cray in particular) can maintain its lead in supercomputing technology over the Japanese and other competitors. The article stated that "he was not alarmed by the recent Japanese developments and believes that the new NEC supercomputer will be no better on actual computing problems than the current top-of-the-line Cray computer, the YMP, introduced last year. Based on what we (Cray) know about the machine achieving peak speeds, it's not a well-balanced machine," John added. "The peak speed that they cite is totally meaningless." We hope John can continue to keep the United States at the forefront in this important technology with its major impact on national defense and business competitiveness. The real threat seems to come from our loss of electronic component manufacturing to the Japanese, with Cray and other potential US manufacturers dependent on Fujitsu and other foreign suppliers for many high-performance semiconductors and

other computer components.

On a lighter note, while wandering through the establishment of my favorite wine merchant here in Birmingham, I discovered a bottle of **David S. Stare Estate Bottled** wine from the Dry Creek Valley. I usually look for Dry Creek wine, and was pleased to see the name of our classmate proudly displayed (along with his distinctive sailing yacht) on the label. Many of us will remember with pleasure the fine wines we enjoyed at the 25th reunion, which all came from Dave's Dry Creek Vineyard. I trust that classmates would be welcome to visit Dave's establishment if they're in the vicinity of Sonoma County, Calif., and maybe even find Dave there if he's not travelling around the world promoting his line of fine wines.

If you haven't done so for a while, drop me a note with your personal news and views to share with other members of the Class of 1962.—**Hank McCarl**, Secretary, P.O. Box 352, Birmingham, AL 35201-0352

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I hope everyone is having a fulfilling summer. Since summer will soon be over, this might be a fitting time to tell your classmates just what has been going on in your life.

While the mailbox is not overflowing, I did get some news about three of us. . . . **Alan Shuchat** wrote to say he is a professor of math at Wellesley. He was in San Francisco some months ago, and got together by chance with fellow local TEP alums Marsh Flam, Oscar Sanchez, Dave Gardner, and others.

The American Association for the Advancement of Science has elected **Michael Feld** a fellow. Way to go Michael! . . . Lake Forest College in Illinois held its 18th annual Advanced Holography Workshop in mid-July. One of the "international faculty of experts" (as described in their press release) was **Steve Benton**. Steve is on the MIT faculty, but since neither he nor Michael wrote to me directly, I cannot tell you any more about what professional and personal things they have been doing (hint, hint).

My computer company, Training To Go, is progressing as is daughter Julie. Of course, we measure her progress in centimeters crawled per second, but it's wonderful to watch. Write, phone, or visit with your news. If you don't, this column will shrivel up and blow away.—**Phil Marcus**, Secretary, 3410 Orange Grove Ct., Ellicott City, MD 21043, (301) 750-0184

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Just a short column this month. Everyone must have been saving their news to pass on in person at our reunion.

Roger Lewis was announced co-winner of the Federal Design Achievement Award for an elderly housing project completed in the early 1980s. The highest award the National Endowment for the Arts can confer, it reflects consideration of design excellence, programmatic innovation, technical and functional performance, and cost effectiveness. The elderly housing project consists of 130 units sited in small clusters in six Maryland towns on the eastern side of the Chesapeake Bay.

Truman Roscoe Brown is a newly elected fellow of the American Physical Society. He was cited for "pioneering application of ^{13}C and ^{31}P NMR to *in vivo* enzyme kinetics and chemical shift imaging in three dimensions."

Ralph Zimmerman writes that he is now the legislative aide at headquarters of the League of Women Voters of New Jersey. Also, as an Olympic-level referee in the sport of fencing, he travels a great deal to Europe and all around the United States.

As you are reading this column, we should have settled into our new life in New Hampshire. Presumably, the first vegetable crop will have come in and the golf scores will be down by 10

or more strokes. Please send your news.—**Joe Kasper**, Secretary, RR 1, Box 181, Lyme, NH

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25th Reunion

Now that I'm back from Harvard and have "lots" of time to write the column, no news. The Alumni Association sent me a clipping of news of the American Physical Society advising that **John Holdren** has been elected a fellow of the Forum on Physics and Society. The citation accompanying his election reads, "For the application of rigorous training in theoretical plasma physics to problems of energy and the environment and leadership in gaining academic recognition for such studies." I believe that John was also quoted this past week in a newspaper article on the implications of the new work on "cold fusion."

Think about a new secretary. I've really decided that 15 of the last 25 years is enough for a while.—**Steve Lipner**, Secretary, 6 Midland Rd., Wellesley, MA 02181

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Melvin Garelick lives in Connecticut with his wife, Jacqueline, and their three children. He has held positions with Grumman Aerospace Corp. and Perkin-Elmer. He has recently joined the faculty of Worcester Polytechnic Institute where he teaches mechanical and aerospace engineering. . . . **Robert Klein** writes that 18 years ago he was part of the founding of Management Decision Systems, which was acquired in 1985 by Information Resources, Inc. He is now leaving IRI to form Applied Marketing Science, a consulting firm focused on "applying Japanese-based product design technology for marketing oriented companies." He says the fun is just beginning. . . .

Richard Gray is enjoying life in Brookline, Mass. He just went on a great sailing adventure off St. Thomas. . . . **Ralph Schmitt** has written a letter to *The Tech*, decrying the loosening of admission standards in order to achieve a more well-rounded student body.

Thomas McDonough has two new books coming out this year: *Space: The Next 25 Years* (2nd edition), and *The Missing Matter* (science fiction). . . . My senior thesis partner, **George Smoot**, has received a citation from the American Physical Society for "careful work on measurements of both the spectrum and large-scale anisotropy of the cosmic microwave background radiation." I'm glad to see that one of us is still putting physics to good use. . . . Bayer USA has elected **Mark Yogan** vice-president and officer of the corporation, responsible for strategic planning. Mark lives with his wife, Judy, and his three sons in the Pittsburgh suburb of Upper St. Clair. . . . Professor **Nicholas Negroponte**, director of the MIT Media Lab, recently presented "Menage a Trois: Living With Computers," as part of the MITRE Institute's Distinguished Lecture Series. A significant part of the Media Lab's research is devoted to how computers and humans will interact in the future, using graphics and language.—**Jeff Kenton**, Secretary, 7 Hill Top Rd., Weston, MA 02193

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As we write this, spring has finally come to the Washington area. The garden is planted and we are about to go to Japan for a two-week vacation. . . . Back in Massachusetts, **Anne Appleton Ripley** and **Bill Carlson** were married on May 28 in Lenox. . . . Today's newspaper reports that **Alan Guth** has been elected to the National Academy of Sciences. He is on the physics faculty at the Tufts and is, we believe, the first member of the class to be so honored. Hopefully, there will be many more. . . . **Paul Taylor** has been awarded the Franklin M. Masters Transportation Engineering Award for his work in estab-

lishing and directing the engineering and construction of a 150-mile rail transit line as acting executive director of the Los Angeles County Transportation Commission. . . . In San Diego, **Jeff Stokes** is working for IRT Corp. on development of real-time electronic imaging techniques for x-rays and neutrons. His wife, **Bonnie Spector**, is an optometrist at the San Ysidro Health Center. Their son, **Jaron Alexander**, is now 2.

Closer to home, **Jim Just** is associate department head of Advanced Systems Department at Mitre Corp. in Washington. His son, **Christopher** is now 8, and his daughter, **Molly** is 2. They spent an enjoyable three-week vacation in Chatham last summer. . . . In the Capitol area is **Jay Hellman** who writes that he has been "researching the relationship between computer and communications technology and office buildings and patterns of land use. My conclusion is a concept of 'virtual adjacency' that relates 'communication' to 'transportation.'" These concepts are being applied to his latest project, a building near the Capitol and Union Station. . . . **Ron Rosen** is in his fourth year of being a scoutmaster and is also chairman of the Dutchess County (N.Y.) Appalachian Trail Management Committee. His two sons, **Alvin** (14) and **Bobby** (10) are active in scouts and sports. . . . From Vermillion, S.D., we hear that **Douglas Goodman** is assistant professor of computer science at the University of South Dakota. His wife, **Barbara**, is assistant professor in the Department of Physiology/Pharmacology at the University's School of Medicine. They have two children, **Cory** (8) and **Tim** (5). . . . So you think your commute is too long—**Shan Cretin** is busy commuting between her family in Los Angeles and Chengdu (that's in Sichuan, China) where she's working on a research project on rural health insurance. Her oldest daughter is a sophomore at Swarthmore and loves it. The youngest two think moving to China would be "tantamount to child abuse." . . . That's all we have for now. Hope you're having a nice summer. Drop us a line about what you've been doing.—**Gail and Mike Marcus**, Secretaries, 8026 Cypress Grove Lane, Cabin John, MD 20818

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Our 20th reunion on June 8-11 will have come and gone when you read these notes, which were composed in mid-May. So whoever prepares the class notes following our gala affair (and it may still be yours truly!) will fill you in on who came, how wonderful the reunion was, and the names of the new class officers. Catching up on some tardy note reporting, **Henry Fuller, Jr.**, reports that he married **Shirley Shields** of Erie, Pa; on December 17, 1988. . . . **Erik Anderson** writes from Mercer Island, Wash., "After nearly 25 years of wondering, Holly and I have returned to the Pacific Northwest to be close to mountains, sea, and family. I have left United Airlines, for whom I worked since graduating, and am now in the marketing department of Boeing Commercial Airplanes." . . . **Chris Ryan** says, "I was delighted to be selected as one of the Entrepreneurs of the Year by Venture Magazine and Arthur Young Company. Geo-Con, which I founded ten years ago, is ready to be taken public and we are researching our options." I'll end this swan song with news of my forthcoming book, *The Starflight Handbook: A Pioneer's Guide to Interstellar Travel* (co-authored with Dr. Gregory Matloff), which is being published by John Wiley & Sons this summer. It's for all you physics and aero-astro folks who wonder about how we may someday get to the stars in person. Now back to my babbling brook in Bow.—**Eugene F. Mallove**, Secretary, 171 Woodhill-Hooksett Rd., Bow, NH 03301

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Harriett L. Burris writes: "As I write, I'm playing single parent while **John**, is off in Japan and China

for a month working. His company (Stone—Safety Corp.) is moving to Greenville, S.C., in January 1990. We're not. The only thing certain is that we are staying in Connecticut." . . . **John H. Morgan** writes: "I became president of Seymour-Sheridan, manufacturer of metal floats and metal bellows in September 1988. Our daughter Sheryl, 15, is a sophomore at The Putney School, Putney, Vt. My wife Barbara is a fabric artist, designing and creating quilts. Our 13-year-old son, Doug, has us doing Nautilus with him." . . . **A. Nihat Berker** has been elected a fellow of the American Physical Society, Division of Atomic, Molecular and Optical Physics for the development of the position space renormalization group technique and its application to studies of phase transitions in physisorbed systems and liquid crystals.—**R. Hal Moorman**, Secretary, P.O. Box 1808, Brenham, TX 77833

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Ed Rich writes that he is moving to Zurich, Switzerland, with his family. He says, "I have been appointed treasurer of Dow Chemical Middle East/Africa/Eastern Europe. We are excited about this opportunity." . . . **Duncan Allen** has relocated to the Boston area. He is involved in opening a Boston office for DeLeuw, Cather, and Co. and is working on the MBTA rapid transit control center and an extension of commuter rail from Ipswich to Newburyport, as well as other projects. . . . **Kenneth Kempson** reports, "Since last I wrote, Catharine and I have added Peter Randolph to our family (15 months), and I changed jobs to become special assistant to the deputy chief counsel of the IRS. I'm still playing hockey, but the other players are getting younger all the time.—**Dick Fletcher**, Secretary, 135 West St., Braintree, MA 02184

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A bit of news to brighten a rainy April morning. **William Stohl** noted the birth of their fourth child, Sara. He is an assistant professor of medicine at Southern California. . . . **Carl Rosenberg** has gone in the other direction, returning to Massachusetts to teach neurology at UMass in Worcester.

The bulletin of the American Physical Society announced recently that **Cherry Murray** was the recipient of the 1989 Maria Goeppert Mayer Award, for "the experimental methods she used to discover two-stage melting in arrays of polystyrene spheres." **Robert Cava** was also cited for "contributions to the materials physics of ceramic superconductors."

Martin Romeo has returned to the East Coast; he is living in Springfield, Va., now and has returned to his barbershop home with the Alexandria Harmonizers, giving the MIT Class of 1973 one of the strongest presences in that august body—two of us.

Not much new on the home front, but for those of you involved in the processes for which video teleconferencing might hold attraction, you may have me calling on you soon. More to come on that. Write!—**Robert M.O. Sutton, Sr.**, Secretary, "Chapel Hill", 1302 Churchill Ct., Marshall, VA 22115

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15th Reunion

Henry G. Heck is in the process of moving to the Black Forest region of West Germany as part of Dow's effort to develop resin and monomers for coatings. He's still single and working for Dow but the details of location and project are changing on a three-year cycle. . . . **Brian E. Jaski** is currently active in interventional cardiology and medical co-director of the San Diego Cardiac Transplant Center at Sharp Memorial Hospitals. Brian indicated that "visitors are welcome" but I

hope none of us are in need of transplants quite yet. . . . **Yosuke Mishiro** writes, "My assignment in Mitsubishi's New York office, after being transferred from Tokyo, is entering into its fifth year. During this time, I had my third child, Kouhei, born in the United States. From April on, I will be working in Mitsubishi's consulting firm, advising both American and Japanese firms for mergers and acquisitions, joint ventures and other business arrangements."

Karl A. Seeler wrote that he was leaving the University of Pittsburgh for Lafayette College in Easton, Pa., where he will teach mechanical engineering, some material science, and "maybe even an occasional lecture in geotechnical engineering." . . . And finally, your devoted class secretary has news to report about herself. I became a member of the firm Pennie & Edmonds as of March 31, 1989—the first woman partner in the firm's 105-year history. And that's all for now. Please write.—**Jennifer Gordon**, Secretary, c/o Pennie & Edmonds, 1155 Avenue of the Americas, New York, NY 10036; or 18 Montgomery Pl., Brooklyn, NY 11215

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The mails have been better for this issue. Please continue to write. From **John Wacker**: "I've been working at Batelle Pacific Northwest Laboratory since July 1987 as senior research scientist. My main focus is analytical mass spectrometry, with forays into meteorics, diamond thin films, and (along with half of the rest of the world) high temperature superconductors. I have two daughters aged 11 and 3, who manage to keep me busy when I am not working." . . . **Marsha Lavoie** is "finishing family practice residency on June 30, 1989. After that I will probably take a job in a Community Health Center in Worcester. Husband **Larry Hardy**, is now assistant professor in Department of Pharmacology, U. Mass. Medical School, with joint appointments in the department of Biochemistry and Molecular Genetics and Microbiology. Sons Jonathan, 6, and Philip, 3, are doing fine." . . . **Richard Winters, M.D.**, writes, "Son, Richard Drew born August 15, 1988; I am now board certified in geriatric medicine."

Daniel Christman writes: "Last spring and summer I built a concrete patio and worked on remodeling the kitchen and replacing most of the house's electrical system. I then went to Hawaii for two weeks in July and August to use my newly-honed construction skills in volunteering help to build the Pacific and Asia Christian University. . . . I joined six other family members and 25 other people for sailing around the Virgin Islands." . . . **Bob Holzwasser** sends a tart comment: "When are you folks at the *Tech Review* going to get off the anti-defense-liberal bit and make some sense? Provide some balance for a change anyway." . . . **Richard McAdoo** is "working away, as usual. No big news to report. As a comment: Am I the only person who is disappointed that our alumni journal, *Technology Review*, is devoted almost exclusively to politics and regulation of technology rather than the technology itself? Does this reflect a basic misstatement of priorities?"

Jerry Dausman has sent word that he moved. "We live on the edge of the suburbs now, almost country (Brookeville, Md.). But that's not the big news. Thom Lizzi, a good friend who started MIT with our class, but graduated in 1975, is coming to visit in a week. But that's not the big news. BIG NEWS. Daniel Paul Dausman was born on April 19, 1989. . . . Mother (Barbara Davies, Wellesley '79), big sister, Amanda, and Dad are doing fine!" . . . **David Anick** was one of 91 young scientists and economists to receive a Sloan Research Fellowship from the Alfred P. Sloan Foundation. The award, \$25,000 over 2 years, is to support fundamental research when government and other support is difficult to obtain.

Your secretary was at a voice trade show to

check out the competition to the Voicebox, our voice interface for PCs, where I ran into **John Nangeroni**. He is in the voice technology area as well, working for Voice Processing Corp., Inc., in Cambridge on Main Street. They occupy a different niche from ours—speaker independent, small vocabulary interfacing. We are large vocabulary, speaker dependent, pc-based. John is house hunting now in Boston, having come in from California. We are making progress selling the Voicebox. Our buyers appreciate the productivity enhancement which comes from being able to construct and manipulate spreadsheets by voice, and to do all bookkeeping and accounting functions by voice. It is incredibly faster than a keyboard. In order to move this product into commercial channels faster, and to develop allied products, I have begun to seek venture capital. By the time you read this, I hope to be in the final stages of a venture deal for financing. On the future front, the currency markets never sleep. As a result, I do not sleep much, either. I have taken up flower gardening too on Sundays to help me relax, as running one business (my brokerage firm) and trying to get another off the ground with my brother is exhausting and nerve wracking. Please write, fax, or call. We need news.—**Arthur J. Carp**, Secretary, Stalco Futures, Inc., 254 West 35th St., 16th Floor, New York, NY 10001, (212) 736-1960, Fax: (212) 736-3664

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Danny Hillis and his company, Thinking Machines, Inc. (located in Kendall Square) were featured in a recent issue of *Boston Business Magazine*. The article describes Danny's brainchild, The Connection Machine, a supercomputer that contains over 65,000 parallel processors and performs 100 million instructions per second. Thinking Machines has been successful raising venture capital and is making inroads into the market.

Due largely to its proximity to our alma mater, Kendall Square, known as "AI Alley," has become quite a center for artificial intelligence companies. It is no longer the urban wasteland that you may remember from our days as under-graduates. In the early '60s, the area was razed in the name of "urban renewal." Plans were also in the works for a NASA control center at Kendall; its location was politically influenced by then-president Kennedy and by the more rational desire to be near the intellectual resources of MIT. After Kennedy's death, President Johnson's influence resulted in the abandonment of Cambridge in 1969 for Houston in Johnson's home state. The new Kendall Square now has some 2 million square feet of office space, a hotel, and a renovated T station, with more development to come. It is said to be the most active location for development in the greater Boston area.

Curtis Scott writes, "I did some work in multiprocessor Lisp at Bolt Beranek & Newman in Cambridge, went to (another Kendall Square AI firm) Symbolics, had a brush with graduate school, and now work on connectionist/neural network applications. I'm also dabbling in land development, doing a subdivision on the side of a mountain overlooking the ocean near Vancouver, B.C., Canada (where we're hoping the Greenhouse Effect will reduce winter rainfall)." Curtis is living in Cambridge. . . . **Rick Losk** has announced his new company, Launch Control, Inc., which offers advice on market analysis, marketing strategy design, and new product planning. He invites anyone launching or thinking about launching a new product to contact him. Rick is living in Tewksbury, Mass.

Cameron Moss writes from Atlanta: "After spending ten years with Bosch, I moved to Munich with McKinsey & Co. We now have three kids and love it!" . . . **Barry Linder** says, "Finished my ophthalmology residency this June. Next year I'll be a fellow in international ophthalmology aboard Project ORBIS flying around the world. ORBIS has a plane with an

JOHNSON
Mayor of

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JOHNSON
Mayor of Salem



In the January issue of *Technology Review*, Paul E. Gray, '54, commented on the need for "interface engineers," people who become "specialists in the political, economic, and social issues that are integral to scientific and technological developments."

Michael A. Johnson, '80, is trying to do just that in Salem, Mass., a coastal community 18 miles north of Cambridge. Johnson is making a bid in the fall election to become the only MIT alumnus in the United States holding the office of mayor (a distinction held for several years by Henry Cisneros, '74, of San Antonio).

Salem has a lot going for it: its history as an early seaport and site of the infamous "witch trials," its wealth of period architecture, and its proximity to Boston make it an attractive place to live and visit.

But as one of America's oldest cities, this community of 38,000 also faces some serious problems: the second most polluted harbor in the nation, a congested city center, and patterns of municipal governance that Johnson says are marked by reactive and outdated approaches to problems.

Johnson is a lifelong resident of greater Salem, and he's decided that his skills are a good match for the community's needs.

For the past four years, he's been a software consultant in mechanical engineering design and analysis, and he believes that his ability to transfer technology to the public sector will set apart his candidacy from those of his opponents.

Although the primary is not scheduled until September, he announced his candidacy last October, and he's been running hard ever since.

Johnson's "platform" includes transforming the city's present data processing department into a modern information systems operation, where information can not only be stored but also easily retrieved to assist in making policy decisions and promote better accountability.

For example, many neighborhoods in Salem were developed when on-street parking was not an issue. Today, however, the number of cars routinely parked on the streets creates a real problem for snowplows and street sweepers. Johnson would like to see an inventory of all property by street address that includes the number of off-street or garage car spaces. The number of spaces could be compared to the number of vehicles registered at each address, giving city officials some hard data on the impact on specific blocks if they were to ban on-street parking. The information could be used to develop plans to serve the needs of car owners inconvenienced by a ban.

Johnson also notes that an information management system would offer electronic mail, a technology that could improve communication among city employees and enable city councillors to provide better constituent services.

Johnson is already employing information technology in his campaign: It's traditional for candidates to purchase the printed listing of all residents of voting age from City Hall, but Johnson purchased the nine-track tape used to create the listing. He converted the data, which includes name, address, date of birth, occupation, and party affiliation, into a Macintosh-compatible format, and imported that information into a custom database. That gives him on-line access to critical information about subsets of the electorate and enables him to target mailings that address the interests of specific groups of voters.

Cleaning up Salem harbor is a sewage treatment issue, Johnson notes. Several years ago, a regional treatment facility was built on prime waterfront property. Owing to poor odor control, the facility has been an aggravation to nearby homes from the start. Moreover, it does not even meet federal standards for wastewater effluent, and meeting those standards requires a secondary treatment facility close to the existing plant. The most

likely site would require taking more than 80 homes by eminent domain, Johnson says, and once again saddling Salem's coastline with an eyesore.

He wants Salem and the regional sewage district board to explore the possibility of treating wastewater at its sources, thereby distributing responsibility for sewage treatment over the entire user community, while at the same time meeting federal requirements and saving a neighborhood.

Johnson seeks consideration of a newly patented device, expected to be on the market in 1990, that would provide wastewater processing at every home and business in the five-community sewage district. The device would be installed in the main plumbing line of each building and would incinerate solids as they are collected, using a microwave process. Applications of the device have been identified by the federal government and have been presented to several states by the inventor, Johnson says.

New technology could also play a role, Johnson says, in the controversial design of a new bridge linking Salem with Beverly. Critics claim the design offered by the Massachusetts Department of Public Works would be an overbuilt solution to a modest problem and would dwarf the waterfront. Supporters of the bridge design say that changing it now would delay the much needed project eight to ten years. But the Massachusetts DPW recently purchased a state-of-the-art, computer-aided engineering system that would significantly streamline any redesign of the bridge, Johnson says. He is optimistic that his understanding of this new technology and his ability to communicate its potential to voters and elected officials will pressure the agency to provide a more appropriate structure within an acceptable time period.

Those voters have their first opportunity to respond to the six candidates for mayor in the September 26 primary. □

operating room, and travels primarily to the Far East and to third world countries. My activities in space medicine continue to fill my spare time."

Ellen Katz received an award from the Massachusetts Capital Projects Office (which she claims is loaded with MIT alumni) for her accessible design guidebook that explains "how to meet the Massachusetts handicapped access code without tearing your hair out." Ellen is practicing architecture with a Boston nonprofit firm specializing in design for people with disabilities. Her husband/classmate **Jay Werb** is in the fifth year of his consulting practice (also located in Kendall Square) specializing in applications software for the transportation industry. Ellen and Jay and their children Julia (age 5) and Daniel (age 1) are living in Newton. . . . **Peter Shaw** writes us from Falmouth, Mass., "I'm a dad again! My wife, Kathryn Kelly, and I are pleased to announce the birth of our son, Julian Shaw Kelly, born November 14, 1988. Julian is welcomed home by his sister, Allison Kelly Shaw (age 4)." Peter is working at Woods Hole Oceanographic Institute.

Life has changed quite a bit for your class secretary and wife, **Diane Curtis**, with the departure of our foster son, Tommy. His being with us changed our lives dramatically (as all of you parents no doubt understand!). After spending eight months with a roaming and increasingly engaging yet mischievous baby (and the accompanying sprawl of toys and other "baby stuff"), the transition back to an "adult" home was pretty difficult. Occasional visits with Tommy in his new home assure us that he is doing well and that he has started off on the right foot.—**Jim Bidigare**, 659 Green St., Cambridge, MA 02139; **Julie Kozacka Stahlhut**, Assistant Secretary for Networks, Internet: jstahlhu@hstbme.mit.edu; Compuserve: Julie K. Stahlhut 76566,1012

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As I write this in May, wondering what happened to spring (it is still in the 50s), it is hard to believe that by the time you read this, we will probably have had a few 100-degree days, like last summer. Hope you are all keeping cool. . . . **Doug Pastorello** has joined Silc Technologies in Burlington, Mass., working with the Physical Implementation Group on static timing analysis. He resides in Hudson, N.H. . . . **Michelle Prettyman-Neely** is in Greenville, N.C., doing a pediatric residency. She has a 3-year-old daughter named Barbara. . . . **Robert Gillis** is a student at Harvard Graduate School of Education and plans to teach physics and coach track at the high school level.

Jeffrey Bloch has finished his first year as a post doc in the space astronomy and astrophysics group at Los Alamos National Laboratory. He has been given a third year for his post-doc and may even be a staff member soon. He reports that the skiing is great and the countryside is gorgeous! . . . **Ted Pounds** writes, "February was a mixed month for me. I became the proud father of a beautiful baby girl, Molly Rose. But my Test Pilot School application was rejected. So now I must figure out what I want to do with my career and whether or not I will stay in the Air Force. Meanwhile, I am still flying, now as an Instructor Pilot and Flight Commander in the FB-111."

Robert and I just finished our successful Off-Broadway run of "Arsenic and Old Lace," also starring Charles Mobbs, '78. After two shows in four months, we are just catching our breath and trying to remember what real life is like.—**Sharon Lowenheim**, Secretary, 500 E. 63 St., Apt. 18B, New York, NY 10021

80 10th Reunion

By this time you read this column, summer 1989 will be coming to a close. Hopefully, it was a good one for everybody! Now, on to the news.

Ron Raines writes, "After obtaining a PhD in chemistry from Harvard in 1986, I have spent the last three years as a Helen Hay Whitney postdoctoral fellow at University of California at San Francisco. In September I will leave Baghdad by the Bay to become an assistant professor of biochemistry at the University of Wisconsin-Madison, where many are cold but few are frozen." . . . Also in academia is **Finley Shapiro**, who finally finished a PhD at MIT in spring 1988. At the end of the summer (last), he moved back to Philadelphia, where he was born and grew up, and joined the faculty of Drexel University. . . . **Andrew Fately** has joined Shearson Lehman Hutton, Inc. as manager of global foreign exchange options. . . . **Eric Kahn** recently returned from a year and a half stint as a project manager in Saudi Arabia with the Saudi Arabian Monetary Agency (SAMA), working for Litton Industries in the Optical Imaging Division. He mentioned that MIT has a good name in Saudi Arabia.

Pat Latterell is still a general partner with Rothschild Ventures, a venture capital firm based in New York. He has been very busy starting new companies in biotechnology and medical devices, including two out of MIT in the last year. . . . **Chris Dunn** married Patricia Mullen last spring and they are now settled into their new home on Cape Cod. . . . **Gustavo de los Reyes** writes that he is now working for AT&T Bell Labs in New Jersey. His wife, Annie Laurie Murray, '81, and he have one girl (2) and another baby due in June. . . . **Kim Zaugg** married Alan Vayda on September 24, 1988. They are living in Lafayette, Ind., and both work for Purdue University, where Kim is an admissions counselor. She writes that she really likes her job but misses the east coast.

On the medical front, last summer **Hillary (Lust) Canning** completed her anesthesiology residency and fellowship at The New York Hospital and married a surgeon, Michael Canning (a Harvard grad). They have now relocated to sunny Miami where they are both in private practice. Hillary invites any former Bakerites to give her a call! . . . **Paul Homsy** wrote that he expected to complete his residency in psychiatry at the University of Texas in July. He is also still doing some engineering consulting on the side and is playing squash avidly two or three times a week. He wishes all his squash friends well and extends an open challenge to anyone who can make it to Houston. . . . **Katherine Sheffield** is a resident in internal medicine at Miram Hospital in Providence, R.I. She plans to finish there in June 1990.

Alison Carmichael Saylor's husband Michael ('78) writes that there was a new addition to their family this year. Ian was born in February. . . . **Scott Norton** received an electrical engineer's degree and an MS in electrical engineering from the Naval Postgraduate School. He is now the electronics material officer on the *USS Blue Ridge*, the flagship of Commander, Seventh Fleet. The *Blue Ridge* is homeported in Yokosuka, Japan, and Scott's had a great time living in Japan and traveling extensively in the Far East. . . . **David Steffy** writes that he is working as a systems engineering manager on the "Pegasus" small space booster for Orbital Sciences Corp. in Fairfax, Va. . . . **Joe Padavano** and he joined OSC about a year ago. He says they enjoy the work but have had trouble adjusting to the East Coast climate after all that time in Los Angeles. . . . As I'm sure some of you know, **Jane H.** and **Todd Chronis** were married while still at MIT. Jane wrote an update: she works for Kodak and Todd is a software consultant. They had twins, Griffin and Iolanthi in 1986. . . . **Calvin Winey** is a senior mechanical engineer for Howtek, Inc., designing color hot-melt ink jet printers.

Elizabeth King writes that she is currently living in Lowell, Mass., and is working at Wang Laboratories as a software engineer. She has stopped using her nickname "Lib" and is now going by Elizabeth. . . . **William Warner's** new company Avid Technology has now grown to ten

people. They raised their first round of venture capital last summer and are working on getting the second round. They were to announce a video editing product at the National Association of Broadcasters Show in April. . . . **Russell Bloon** writes that he is engaged to Debra Gorman (Penn State '76). They toasted Christmas with Anne and Ed Gillett and Amy and John Stenard at the Stenard's house in Wallingford, Pa. The best gift was his new SHO. He says: "Ed proved again his willingness to drive my car harder than I ever had. The general atmosphere was reminiscent of the old days of let's ride Russ's motorbike, without **Howie Seidler** to do the aerials!" In addition, Ed Gillett writes that he quit his surgical residency and took a job as an emergency room attending in a local hospital. Ed's wife is pregnant with their first child and they are building a house. "Otherwise, life is status quo." John Stenard is still rebuilding ships as an officer in the Navy at the Philadelphia Naval Ship Yard. Ed celebrated New Year's with Kim and **Bob Humphries** in Washington, D.C., where Bob is a lawyer.

Two of our classmates showed up in the news recently: First, **Yet-Ming Chiang** was mentioned in *Mass High Tech* as a founder of American Superconductor Corporation in Cambridge. And *The University of Chicago Chronicle* mentioned **John Grunsfeld**, who is a W.D. Grainger Postdoctoral Fellow in physics there. As part of his fellowship, John was supported in researching the study of solar flare electrons.

Finally, it is my sad duty to report the death of our classmate **Jonathan Mayo** on March 6, of this year. Thanks to everyone who wrote in the last few months. I look forward to more news in the coming months.—**Kate Mulrone**, Secretary, 118 Riverview Ave., Washington Crossing, PA 18977

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Hello again. You probably noticed that the class notes of 1981 were missing from the last issue of *Technology Review*. That was because nobody wrote me. Fortunately, my mailbox has had a little more activity lately—besides the usual junk mail!

The first letter to break the dry spell came from **Susanne Prokscha**, who is living with her husband in Munich, Germany, where she is working for BBN Software. After graduating from MIT, Susanne did graduate work in physics at Brandeis before moving into the computer-software field. She plans to stay in Germany for two to three years, after which she will move back to the Boston area. Thanks for writing!

Daniel Harasty was married last November. His wife, Susan, is working for the State Department of Environmental Protection, and Dan is still with Bellcore. . . . **Gus Gonzalez-Rivas** reports that while he failed to make the Olympic fencing team, he ended up as the first alternate. . . . **Annie Laurie Murray** and her husband, Gus, have moved to New Jersey with their two children, according to **Julie Neuringer**, who will have returned to Boston from Dallas by the time this column appears. Julie will specialize in kidney transplant at Brigham and Women's Hospital.

Peter Balcewicz is living in El Segundo, Calif., and was married to Penelope Ann Anibas last September. Congratulations. . . . **Max Sirrine** married a girl from his hometown of Gardiner, N.Y., in 1983. (Better late than never . . . thanks for the timely news!) They have two boys, ages 5 and 1, and live in Gardiner, where Max has worked as a New York State correctional officer in the Wallkill Correctional facility for seven years.

Kenneth McDonald worked at Texas Instruments in Houston after graduation and then sold for Hewlett Packard for two years before a two-year stint at the MBA school up the river. Since graduating from Harvard B School, Ken has been working with inventors in their attempt to get companies started. . . . **Joann Stock** has been ap-



At the wedding of David Kazdan, '81, and Laura Gooch, '82, at Thistle Hill, Fort Worth, Texas, a photo was taken which included these MIT alumni. (From left to right) Front row: MIT Professor Karen Gleason, '82; Karen Fortal, '82, David and Laura. Middle row: Robert S. Gooch, '51, Bill Gooch, '78, Tom Gooch, '77, Johnathan Richmond, G, and Matthew Stern, '82, with the unauthorized appearance of David's nephew to the left. Back row: Suk Lee, '82, and Emi Lee, '84 (who were married in 1987), and Ken Segel, '83.

pointed assistant professor of geophysics in the Department of Earth and Planetary Sciences at Harvard University. Congratulations.

Closer to home, my husband Ned, son Eric, and I have relocated to Boca Raton, Fla. Please write to me at my new address.—**Lynn Radlauer Lubell**, Secretary, P.O. Box 810592, Boca Raton, FL 33481-0592

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Happy news on our classmates' personal lives: **John Hainsworth** called to say that he planned to marry Deirdre King in June. John works for Digital Equipment Corp. in Nashua, N.H. . . . **Lily Ablondi** and her husband Mike are the proud parents of Nicole Marie, born March 30. The family lives in Ohio.

Jeffrey Mai was recently promoted to customer support manager at Aspen Technology, Inc., a Cambridge modelling software company where he has worked since 1984. . . . **John McCauley** graduated with the Sloan class of 1989; he is the father of Matthew, who is 2½ years old. . . . **Michelle Moas** is enrolled in the marketing PhD program at the R. B. Pamplin School of Business at Virginia Polytechnic Institute and State University. She writes that "Blacksburg is a beautiful town, and I'm having a great time!"

Congratulations to East Coast correspondent **Linda Schaffir** for purchasing her first condo. I'm sure she'd love to have the first mailbox she's ever owned filled with letters from classmates. Please write to Linda (50 Aiken St., Apt. 512, Norwalk, CT 06851), West Coast correspondent **Michelle**

Gabriel (656 S. Fair Oaks Ave., Apt. D-211, Sunnyvale, CA 44086) or me.—**Stephanie Pollack**, Secretary, 722 W. Roscoe St., Apt. 204, Chicago, IL 60657

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I received a note through MIT that **Gregory Armstrong** has been awarded an NSF-NATO postdoctoral fellowship. Greg will be studying plant molecular biology at the Max Planck Institute in Koln, West Germany, for 12 months. He was one of 54 award winners in the country.

MIT also sent a press release from Bytex Corp. announcing the appointment of **Elaine Martel** as services product manager. Elaine was formerly at Data General for six years, and is living in Westborough, Mass. The press release came with a large glossy photo of Elaine, which I plan to auction off to the highest bidder. All proceeds will of course go to the class of '83 secretary's fund.

I received the following notes from people who took time to write while giving money to MIT. . . . **Sara Weber** writes that she is working as manager of "C" program development at Interactive Images, Inc. Sara and her husband, Dan Ottenheimer, '79, recently chartered a yacht in the Caribbean, and had a great time scuba diving and relaxing. . . . **Betsy Pollack** lives in Arlington, Mass., and is working for ITP in Cambridge. Betsy is developing factory control systems for automated factories. . . . **Bruce Campbell** is living in Alexandria, Va., and is working on the space station at NASA Headquarters in Washington, D.C. . . . **Steve Kim** writes that he is a resident in general surgery at Barnes Hospital, which is associated with the Washington University Medical School in St. Louis.

I've got the following news from Delta Tau Delta, as classmates will be converging from all points of the globe for the fraternity's centennial this summer. . . . **Steve Yoon** was married to a fellow Johns Hopkins School of Public Health classmate named Paula in Wilmington, Del., on January 28. Steve is currently living in Geneva, Switzerland, and working for the World Health Organization. . . . **Ken Krugler** and **Chris Schneider** are working for their own company, Transpac Software, and are frantically rushing to release their Japanese word-processing product for the Macintosh. . . . **Mike Santullo** and **Kinta Foss** are working for Raynet (a division of Raychem) in Menlo Park, Calif. Mike recently bought a house, and somehow coaxed two California women to move in with him. . . . **Steve DeFalco** is enjoying work at McKinsey in New York, and he and wife Rosemarie are expecting another baby. . . . **Doug Sargent** is living in Winthrop, Mass., and is working for both Lotus and Global Villages. . . . **Randy Schweickart** and **Michelle Heng**, '84, are also expecting another child. Randy is working at Becton Dickinson, and Michelle will be taking a job at Burroughs Wellcome when she graduates from Duke Medical School this spring. . . . If anyone has seen or heard from **Joe Masci**, please write.

I am formally challenging the first pledge in each living group's pledge class to take responsibility for writing class notes and telling the rest of us what is going on. Remember, don't let the truth get in the way of a good story!

I'd like to thank **Guillermo Chang** for filling in for me last month. I was down in the British Virgin Islands doing research on pina coloda construction techniques. Please keep those cards and letters coming.—**Jonathan Goldstein**, Secretary, 2 Soldiers Field Park, #201, Boston, MA 02163

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Just a few pieces of news this month were all that came in the mail to me. **Daniel Felten** was an environmental engineer/consultant until 1988, but is presently self-employed as a building contractor/carpenter in New Haven, Conn. Good

news—his first baby was due in June. . . . **Catherine Seidel** is "happily married to Mark Siedel, '83; three children: Robert (3 1/2), Ruthanna (2), and Timothy (1)." . . . **Alan Wiersba** "continues to enjoy [his] work with Oracle Corp., first as product manager/designer in San Francisco and now as sales support technician in Los Angeles. In my six years, Oracle has grown from 55 to over 3,000 employees. They tell me Oracle now hires more graduating seniors from MIT than any other corporation (around 70 this year)." . . . **Lillian Chang** is at the University of Tennessee, getting her PhD in molecular biology. . . . **Ellen Williams** is getting married, but I don't know who the lucky person is.

This will probably be my last column. At our reunion in June, a new secretary was due to be voted into office. I have enjoyed (for the most part) writing the column for these past four years, and I hope that you have enjoyed reading them. I especially want to thank **Diane Peterson**, **Lisa Tener**, and the staff at *Technology Review*. Diane and Lisa spent a good deal of their time writing columns, and the staff was great in getting us information and letting us know when the columns were due. Good luck to everyone; please help our new secretary by writing in often. Meanwhile, I plan to enjoy a bit more of the California sunshine. Bye!—**Mona Wan**, Secretary, 12231 Viewoak Dr., Saratoga, CA 95070

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5th Reunion

Richard J. Higgins was elected to the American Physical Society's Instrument and Measurement Science Topical Group in recognition of his "contributions to electronic and microcomputer instrumentation of improved measurements of metals, alloys, and semiconductor heterostructures." . . . **Peyman Pakzaban** was elected to membership in the Alpha Omega Alpha medical honor society at Baylor College of Medicine. His specialty is neurosurgery and he is a DeBakey Scholar. . . . **Micheline Saxton** (formerly Fradd) was married last October and now owns a house with a dog and a cat.

If you are interested in helping to organize the class reunion, or if you have suggestions for activities, please get in contact with me.—**Stephanie Winner**, Secretary, 1026 Live Oak Drive, Santa Clara, CA 95051, Internet:winner@apple.COM, (408) 985-6827

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Hello. I hope everyone is enjoying the summer. . . . **Kirk Chas** completed his master's in electrical engineering at MIT last September. He now works for Lotus Development in Cambridge as a software consultant. He is saving money to take an extended trip to Asia. . . . **Ed Mount** works with numerous other MIT alumni at O'Connor & Associates in Chicago, where he trades options in the pits of the Chicago Mercantile Exchange for the foreign currency area of the firm. Ed is pursuing an MBA at the University of Chicago, taking night classes. . . . **Scott Bentivegna** is a lieutenant (j.g.) in the U.S. Navy, serving aboard the U.S.S. *Ulysses S. Grant*. He owns a house in Connecticut near his home port.

Lieutenant **Greg Harrison** works on an SDI program for the Air Force, while he attends the University of Southern California part time, expecting to complete his master's in aerospace engineering by December. In his spare time, he is learning the fine California art of beach volleyball. . . . **Robert Greenfield** moved to Allentown, Pa., to take a job with Bell Labs. He says it's a good job but a dull town. . . . **Desmond Kirkpatrick** is a CAD software engineer at Intel, working in layout synthesis (place and route).

Bill Herlan left Aerojet in Sacramento to return to Seattle and the rain. He was not disappointed: 29 days of rain in January, 25 in March. After five months, he found the perfect job at Heaton

Composites; they make repair equipment for composite materials and provide training in their use. He is only the 15th person in the company, so his job description is very broad: training, sales, technical work, etc. Bill gets to travel to some interesting places, including Beijing and Frankfurt. During Bill's senior year at MIT, his roommate, Tina Bartschatt, '89, heard from an old friend, but Tina was so busy doing 18.03 problem sets that Bill offered to return the correspondence, and he finally arranged for Tina's friend to visit her as a surprise. Now Tina's old friend, Sarah, is engaged to Bill.

Steven Wheatman and **Ellen Spero** write from Reading, Pa., that they will be getting married in September on Long Island and will honeymoon in Mexico. **Ann Zabludoff** will be one of the bridesmaids; she is studying for a PhD in astronomy at Harvard. Ellen works as a consultant for Oracle in New Jersey along with **Grace Chen**. Steven works for Arrow, a medical products company in Reading, Pa., and is studying for his master's in electrical engineering at Pennsylvania State University during the evenings. Ellen received her master's from Sloan in February, 1987. Ellen and Steven attended the wedding last December of **Eric Raiten** and **Alla Pozniakov**, '88. **Adam Becker** and **Stewart Clamen** were also there. Stewart is in graduate school at Carnegie Mellon; Adam is studying math at the University of Chicago; Eric is working on his PhD at Cal Tech, and he was in Italy over spring break attending a conference. Ellen and Steven have attended several MIT Club of Lehigh Valley activities where the average age was 60, and they are extremely interested in finding other recent MIT alumni in the area to help them lower the average.

Jim Wilkerson planned to get married in June. Jim is stationed at Eaker AFB in Blythesville, Ark., where he flies tankers for the Air Force. . . .

Brian Miller will attend Stanford Business School this fall. . . . **Rich Maurer** is studying for his MBA at RPI Business School. Rich is stationed at Griffiss AFB, in upstate New York. Rich recently visited Las Vegas along with **Noel Zamot**, where he hoped to meet up with **Karl Tucker**. . . . **Marilyn Oberhardt** planned to finish her master's at MIT in July. She recently presented a paper on her shuttle potential return electron experiment at the Tethered Satellite Conference in San Francisco. . . . **Stewart Cobb**, '85, recently arrived at Los Angeles AFB; he's working in my office. . . . I recently returned from a business trip/vacation to France. My fiancée was able to meet me in Paris, and we're going to write a book about how to see all of France, part of Italy, Andorra and Monaco in four days. But the trip was great. By the way, I've picked my bridesmaids: **Ellen Epstein**, **Anne Fricker**, and **Karen Wohl**. Who would have guessed? Talk to you next month.—**Mary E. Cox**, Secretary, 1800 Hermosa Ave., Apt. A, Hermosa Beach, CA 90254

87

Hi, everyone! I hope you've all enjoyed your summer. I bet lots of you have done some great things recently. Get out those pencils and papers or turn on your PC and write me a letter so I can share your adventures with the class.

Meanwhile, I do have some information to give you. . . . **Rachael Colton** is working as a network design engineer for Southern Bell in Atlanta. She married **Jon Colton**, '81, in August 1987. Last year Rachael and her husband bought an old house, and they are busy renovating it. . . . **Patrick Kim** spent his first year after graduation in Switzerland, at the ETH (Swiss Federal Institute of Technology) on a Fulbright scholarship. He is now completing his M.S. work at U.C./Berkeley, and will return to Switzerland after he finishes this summer. . . . **Michael De Cavalcante** writes from New York where he's working for Touche Ross, Management Consulting. After having participat-

ed in the Ironman Triathlon in 1988, he's looking forward to starting his MBA in September.

Alex Chow writes from Gainesville, Fla., to congratulate **Kaveri Suryanarayan** and **Mark Mastandrea** on their engagement! . . . **Chris Dorn** is living in San Bernadino, Calif. (outside L.A.), in a condo with her sister. She's doing Aircraft maintenance at Norton Air Force Base. (The base will be closing soon, so Chris doesn't know what's coming next.) California has been loads of fun and definitely different from the East. Chris went to a party in LA and saw **Tony Ricobono**, '84 (Remember the Bakerite with the red hat?) and **Juli Urfrig**, '88. They both work at Hughes. . . . **Sue Hughes** is at pilot training in Phoenix, Ariz. She'll be in the air force for a while. . . . **Chris Young** has been traveling all over the country and to England and is loving it. He also broke his leg this winter and was laid up for a few weeks.

Art Gregory writes with loads of information. . . . Art is working at Cobe Laboratories, Inc., in Arvada, Colo. He writes: "I'm having fun in Denver working on heart/lung machines and skiing with fraternity brother **Gordon Beckhart**, '84. Spring skiing in Jams of course! Classmate **George Zachary** visited Denver in his recently purchased '62 T-Bird convertible (banana yellow, of course). He was on his way to California to live with fellow classmate **Gordy Holterman**. These two should get very tan, since Zac is sort of looking for a job, and Gordy is finishing law school in May. Congrats!

"Other '87 graduates met at MIT in April to celebrate the 100th Anniversary of their fraternity, Phi Gamma Delta. **Duncan McCallum**, **Brett Giles**, **Glenn Hopkins**, **Dave Solo**, **Rich Rice**, **Mike Donahue**, **Augie Peccei**, **Chuck Thompson**, **Bob Joy**, and **Steve Brown** joined myself (Art) and **George Zachary** and **Gordy Holterman**. Duncan is working at Draper Labs and taking classes toward a PhD at MIT. Brett managed to tear himself away from Washington, WVA, where he works for G.E. Plastics, in order to be at the reunion. Glenn and Rich provided places to stay for this crew of people, as they remain in the Boston area. Auggie, Chuck, and Mike are building houses on speculation on the Cape. Anyone want to buy a house? They've got one!

"**Bob Joy** is continuing his education in the University of Vermont Medical School only because of his fetish for being called 'Dr. Joy' and 'Dr. Bob Joy'. . . . **Dave Solo** is on temporary assignment at the London Board of Trade where he still "buys and sells money" for a prestigious Chicago options firm. . . . **Steve Brown** just earned his wings in early April as a navigator for the United States Air Force. Congrats! All the above wish to say hello to the other '87 graduates, and would like to say that MIT friends are friends that last!"

That's all the news I have for now. Keep those letters coming; I need your help. Thanks!—**Stephanie Levin**, Secretary, 41 Prentiss St., Cambridge, MA 02140, (617) 547-6673

88

I recently received the good news that **Gary Leskowitz** and **Andy Hong** were not killed in an auto accident while driving across country in January as was reported in the May/June issue. Profound apologies go to them, their friends, and their families for any difficulties this error may have caused them.

Belated congratulations to all who graduated this past June. Please don't forget to write about your upcoming jobs and plans. . . . **Kurt Glitzenstein** sends greetings from California. Apparently there was a mini-reunion in Palo Alto. **Tina Berceci**, **Jen Raeder**, **Pascale Kavanaugh**, **Tom Spitzenagle**, **Bill Flowers**, **Bea Silney**, and **Kurt** were reportedly "hanging out in Santa Cruz and drinking Napa's Finest."

More news from California: **Larry Claman** attends Stanford and plans to obtain his master's

degree in electrical engineering in June. He spends some of his free time as a DJ for KZSU, Stanford's radio station. . . . Also at Stanford are **Cathy Sybert** and **Lisa Rockoff**. Cathy intends to get a master's in aeronautical engineering in August. Lisa expects to receive her master's in mechanical engineering in June. . . . **Dan Mittleman** attends graduate school in physics at the University of California, Berkeley, and plans to be finished by "at least 1994." Meanwhile, he is "wasting time playing frisbee and enjoying California." . . . **Terry Olkin** is employed by Oracle and working on his tan. . . . **Chris Racicot** and **Tom Murray** have an apartment on the beach just south of Los Angeles, and are immersed in the California lifestyle. Chris works at Xerox as a software engineer, designing the next generation of high-tech laser printers. Tom works at TRW, "doing something secret with satellites."

Now for some news closer to the homefront: **George Haldeman** works at Lincoln Labs. . . . **Reggie Tucker** and **Steve Foster** live outside of Cambridge. Reggie is in mechanical engineering graduate school, and Steve attends school while working at DEC. . . . **Marc Filerman** lives in Somerville and attends graduate school. . . . **Abdon Ruiz** lives outside of Boston and works for the State Election Commission. . . . **John Manthorpe** works at Bain in Boston. . . . **Tareq Hoque** has also entered the world of management consulting by working for Bain. . . . **Ken Fujimoto** works for Myers-Holum in Boston and spends most of his time traveling around the country. . . . **Steve Woolfson** is in the Harvard-MIT STS program. . . . **George Pappas** attends aeronautics-astronautics graduate school at MIT and lives in Arlington. . . . **Perry Ziff** works for McKinsy and Co. in Cambridge, he is currently assigned to Japan, where he is enjoying himself greatly.

Darrin Tebon works as an engineer in structural design on the ATF prototype vehicle at General Dynamics in Fort Worth. He enjoys the Dallas night life intensely and has taken up skydiving. . . .

Craig Jungwirth works for Walt Disney in Orlando on the new Disney MGM Studios Tour. He and four other MITers organized a gathering for MIT alumni in the Orlando area. If all goes well, a new MIT Club may be in the works. . . . **Larry Rosen** is going to medical school next year. . . . **Aida Ayaya** is a chemical process engineer for the isopropyl alcohol unit within the performance fluids section at Exxon Chemicals in Baton Rouge, La. . . . **Scott Lordi** is reported to be desperately trying to finish his thesis and not get kicked out of the University of Illinois at Urbana-Champaign. . . . **John Rondinella** works for Sumitomo bank in New York City.

Over spring break, a bunch of ex- and current Bakerites got together in Aspen, Colo., for skiing and partying. Among those attending the festivities were **Andy Brockman**, **Denis Gulsen**, **Larry Claman**, **Mark Longtin**, **Terry Olkin**, **Cathy Sybert**, **Tareq Hoque**, **Perry Ziff**, and **Steve Stein**. Andy is working on a master's in electrical engineering at Cornell and then plans to work for Bell Communications Research in New Jersey. Denis has specialized in computer networking at Advanced Micro Devices and is featured in AMD's new college brochure. Mark works in Chicago for ZS Associates, a financial consulting firm. Steve is enrolled in the MD-PhD program at New York University Medical School with the hope of "someday saving mankind by finding the cure for a hangover."

Eric Swenson is getting married to Sue Hughes, '87. . . . **Christopher Cook** planned to marry **Kathy Mawn** (Simmons '88) in May. Christopher is in Navy flight school with **Dave Sildorff** and **Chris Saito** in Pensacola. Dave and Chris expected to move to California in June for navigation training in P-3 aircraft. . . . I look forward to spending a summer in Boston working in the department of orthopaedic research at Mass. General Hospital. Please let's keep those letters coming and thanks for all your help.—**Grace Ma**, Secretary, 435 E. 30th St., New York, NY 10016



COURSE NEWS

I CIVIL ENGINEERING

After one and a half years with the Deutsche Bank in New York, **Peter P. Macke**, CE '85, is now back in Germany as an assistant vice-president with Deutsche Bank's international project finance group. . . . **Alonso E. Rhenals**, CE '75, reports that he is still working at The Analytic Sciences Corp. (TASC) in Reading, Mass., as a department staff analyst. His fourth son, Daniel Fernando, was born in March. . . . **Louis M. Wenick**, SM '77, is president of Technical Service Systems in Panama City, Fla. . . . **Jerome B. York, Jr.**, SM '61, formerly vice-president of the Dodge Car & Truck division of the Chrysler Corp., has been promoted to vice-president and controller of the Chrysler Motors Corp., the automotive unit of Chrysler. . . . Currently senior vice-president with H.J. David Development Corp., **Nicholas J. Machnik**, SM '77, is working on "200 High Street," a certified historic rehabilitation in Boston's business district, and "201 Broadway," a 120,000-square-foot speculative office building in East Cambridge.

George Bugliarello, ScD '59, is one of two recipients of the 1989 Founders Medals awarded by The Brooklyn Hospital-Caledonian Hospital for "substantial contributions to the welfare and prestige of the borough of Brooklyn." The Medals, which traditionally are awarded to an individual and an institution, also went to the Brooklyn Gas Co. Bugliarello is president of Polytechnic University and chairman of Metrotech Corp., the latter a 16-acre development project that is transforming downtown Brooklyn into a large academic-industrial park. He was cited also for distinguishing himself in the areas of computer languages, biomedical engineering, and fluid mechanics. . . . **Robin Keith McGuire**, PhD '74, has been elected to the board of directors of the Seismological Society of America for a three-year term. He is president of Risk Engineering, Inc., of Golden, Colorado, a consulting firm specializing in probability and risk applications to engineering systems.

Sidney G. Albert, SM '32, a philanthropist and former board chairman and president of the Albert Pipe Supply Co., died of cancer at his home in Clearwater, Fla., on February 17; he was 80 years old. Albert had been a member of MIT's Educational Council, a founder of the Albert Einstein College of Medicine, a trustee of the Polytechnic Institute, and a board member of the Mease Hospital Foundation in Safety Harbor, Fla.

II MECHANICAL ENGINEERING

Professor **Adrian Bejan**, PhD '75, was awarded the J.A. Jones chair in mechanical engineering at Duke University. . . . **J. Stanley Cobb**, SM '47, a mechanical process engineering consultant in Martinsville, Va., has been elected vice-president of Region IV of the American Society of Mechanical Engineers. . . . **Daniel M. Hancock**, SM '73, is currently chief engineer of advanced power-

train systems for Chevrolet-Pontiac-GM Canada Group of the General Motors Corp. . . . **J. Lowen Shearer**, ScD '54, is now professor emeritus at Penn State University—but is still active in ASME and writing. . . . **Mark C. Sellnau**, SM '81, is working on control systems for auto engines at GM Research Labs; he is also developing a new rig and sail for the Olympic catamaran "Tornado," for the 1992 Olympics. . . . **Michael S. Idelchik**, SM '81, is working on high-performance nonlinear control systems for advanced jet engines.

Peter Kalustian, SM '34, writes: "My international consulting business in the field of food fat and derivative processing continues to be very active with current clients in Australia, Malaysia, Italy, Mexico, and of course the United States. However, somehow I find the time to continue my downhill skiing, and have 72 days skiing to date this season. Most of it is in our local New Jersey area, but also included trips to New York, Vermont, and eight days in Utah. I tell my friends that I am working up to being a ski bum! I also have a philosophy that one week of skiing adds one month to my life span. My health is fine and I enjoy my children and their families, including my 15-year-old grandson Karl and 14-year-old granddaughter Clare Marie, who also really enjoy skiing, along with their other activities."

Professor **Robert H. Cannon, Jr.**, ScD '50, chairman of Stanford's Department of Aeronautics and Astronautics, is a member of the National Research Council's newly reorganized Aeronautics and Space Engineering Board. . . . **Chad Joshi**, ScD '87, is one of four scientists and a number of MIT alumni at the American Superconductor Corp. of Cambridge, founded in the spring of 1987. The company has exclusive licenses from MIT and Argonne National Laboratories to several proprietary processing technologies for the new high-temperature superconductors.

The Alumni Association has received word of the death of **George H. Hotte**, SM '43, on March 10 at his home in Palm City, Fla. He was professor emeritus of textile technology at the University of Connecticut; prior to his teaching career, he had worked in textile research and marketing for Firestone, Wellington Sears, Tennessee Eastman, Allied Chemical, and Tex Plant. Hotte was the recipient of the Service Award Medal in 1979 from the Textile Institute of England.

III MATERIALS SCIENCE AND ENGINEERING

Woonsup Park, PhD '88, has begun working at Rockwell International this spring after a year at Douglas Aircraft Co. He is developing titanium aluminide materials for the National Aerospace Plane (NASP). . . . **Thomas E. Mates**, SM '85, is pursuing a PhD in polymers at Cornell. . . . From Mountain View, Calif., **C.D. (Dave) Himelblau**, MAE '75, writes that he "recently served as program chairman for the Golden Gate Materials Technology Conference in Santa Clara, Calif. This is a nationally recognized conference, unique for its multi-disciplinary nature through

participation by ASM, AWS, NACE, ASNT, and TMS. MIT speakers included Professors **Nicholas J. Grant**, ScD '44, **Ron Latanision**, and **James Cornie**. . . . Upon retiring from teaching at the Brown University Division of Engineering in January 1988, **Joseph Gurland**, ScD '51, served as visiting scientist at the Max Planck Institute for Materials Science in Stuttgart, West Germany, through March of that year. He was awarded the 1989 Plansee Medal this past May at the Plansee Conference on Powder Metallurgy.

Among the MIT alumni at the American Superconductor Corp. of Cambridge (founded in the spring of 1987): Director of Technical Applications **Carl Russo**, PhD '78; scientists **Larry Masur**, PhD '88, and **Kenneth Sandhage**, PhD '87; co-founder **Yet-Ming Chiang**, ScD '85; Technical Advisory Board member **Frank Fradin**, '63; and Board of Directors member **Jess Belser**, '52. The company has exclusive licenses from MIT and Argonne National Laboratories to several proprietary processing technologies for the new high-temperature superconductors.

The Alumni Association has been notified of the deaths of **Byron H. Auken**, SM '72, on February 1, 1989, and of **H(enry) Gordon Poole**, '41, on September 8, 1988. No further information was provided.

IV ARCHITECTURE

Kurt F. Eichenberger, MAR '82, recently finished a library for Wake County, N.C. His new projects include a study for a shelter for the homeless and a day-care center. . . . **Frederick L. Merrill, Jr.**, SM '80, has been promoted to associate vice-president of the Robbins Group, a Cambridge-based real estate development firm. He is in charge of the planning, permitting, and design process for a variety of residential and commercial development projects in New England. . . . **Harold R. DeMoss III**, SM '88, has joined the real estate development firm of Independent Development Co., Inc., as assistant vice-president. The firm is located in Newport Beach, Calif., with operations in California, Texas, Florida, Michigan, and Nevada. DeMoss lives in Mission Viejo, Calif.

From **Rosalie E. Ennis**, MAR '76: "I have been working as a staff architect at IBM's T.J. Watson Research Center, and am looking forward to managing future renovations of the Saarinen Building." . . . **John H. Larson**, MCP '55, retired in April as president and CEO of the Connecticut Energy Corp. in Bridgeport. . . . **Alex Loy Seid**, MAR '74, writes that he has been accepted to the MBA program at Boston University's School of Management for the fall semester. "A mid-career correction from Architecture/Planning," he says. He was also listed in the 22nd edition of *Who's Who in the East* (November 1988).

Word has reached the Alumni Association of the death of **MacDonald Barr**, MCP '57, of Brookline in 1986. No further information was available.

V CHEMISTRY

Richard C. Fix, PhD '56, is currently director of technical services for Clean Harbors, Inc., where he is responsible for Clean Harbors Analytical Services, Inc., a full-service analytical laboratory with about 55 people, and Clean Harbors Environmental Engineering, Inc., with about 70 employees engaged in all aspects of hazardous waste management. Clean Harbors, reports Fix, is the largest environmental services company in New England. . . . From **Barbara Van Tassel Enagonio**, PhD '50: "I will retire in June 1989, as professor of chemistry at Montgomery College, Rockville, Md., where I have been on the faculty since 1966. I served as chairperson of the Department of Chemistry from 1979-1982. In a recent *Technology Review* my three daughters were mentioned. I was sorry that you omitted mention of my four sons! I also want to announce the birth of twin grandsons in December 1988: Nicholas Andrew and Michael Thomas Enagonio—perhaps future MIT students!"

Corning Glass Works research scientist **S. Donald Stookey**, PhD '40, was named a distinguished life member of the American Ceramic Society at its annual meeting in April. Among his many inventions are photochromic glasses, photosensitive glasses, polychromatic glasses, and glass ceramics. He has more than 60 patents and received the President's Medal of Technology in 1986 at a White House ceremony. Though he officially retired as director of fundamental chemical research in 1978, Stookey remains an active consultant to Corning.

Dabney White Dixon, PhD '76, is now an assistant professor in chemistry at Georgia State University in Atlanta. She is the recipient of an NSF Career Advancement Award; her research involves biological roles of metalloporphyrins with emphasis on electron transfer. . . . MIT Professor of Chemistry **Richard R. Schrock** was recently elected a Fellow of the American Academy of Arts and Sciences.

Peter Y. Johnson, PhD '69, an associate professor of chemistry at the Illinois Institute of Technology, has been named dean of undergraduate affairs for the university. He is responsible for all undergraduate curricular matters, including IIT's honors program, the Educational Technology Center (ETC), and Project Hawk, an innovative IIT program designed to introduce freshman to college-level computing and their major field of study. Johnson came to IIT in 1976 from The Johns Hopkins University, where he had taught for seven years. In 1985 he became director of IIT's Summer Institutes on Computer Modeling in Mathematics and Science for Gifted High School Students. In 1987 he was appointed director of the ETC, the university's center for self-paced instruction and undergraduate tutoring in mathematics, physics, chemistry, and computer science.

James Beatty, PhD '60, professor of chemistry at Ripon College in Wisconsin, was one of six professors to receive the college's Severy Awards for excellence in teaching this spring. He was cited for his high level of dedication to excellent teaching, good humor, and helpfulness to new colleagues.

VI ELECTRICAL ENGINEERING AND COMPUTER SCIENCE

Robert E. Brucoler, SM '79, has joined the Squibb Institute for Medical Research in Princeton, N.J., as a research fellow in the Macromolecular Modeling Department. . . . **Stephen Filippone**, SM '88, is currently working with the GE Co. in Lynn, Mass., where he is in the manufacturing management program at GE's "Factory of the Future," which is an automated factory producing aircraft engine parts. . . . Since April 1988, **James R. Seeley**, EE '77, has been head of the U.S. Navy's Radar and Identification



P.Y. Johnson



S.D. Stookey

Programs for the Office of the Chief of Naval Operations in the Pentagon. . . . **Jerry L. Prince**, PhD '88, joined the faculty of The Johns Hopkins University as an assistant professor in the Department of Electrical Engineering and Computer Engineering in January 1989. . . . **Ahmed H. Tewfik**, ScD '87, is currently an assistant professor in the University of Minnesota's Department of Electrical Engineering, which he joined in September 1987. . . . July 31 is the planned retirement date for **R. Gene Shelley**, SM '49, president of Raytheon Co.

David I. Kosowsky, ScD '55, has resigned as CEO and director of Damon Biotech, Inc. in Needham, Mass. . . . From **William D. Hunt**, SM '80: "I have been named a 1989 NSF Presidential Young Investigator, and am enjoying life as an assistant professor of electrical engineering at Georgia Tech." . . . **Paul Tseng**, PhD '86, is continuing his research on numerical optimization at the Laboratory for Information & Decision Systems at MIT.

Researchers at BU and MIT are collaborating on a NASA satellite experiment that seeks to measure the electrical charge emanating from the sun. Project Wind, as it is called, will carry out a seven-year mission aboard a solar space laboratory built by GE. The six-foot-tall, four-foot-diameter circular lab will also carry solar research devices from other universities. BU is responsible for producing microelectronic sensors that will measure the extremely low levels of electrical energy in high-speed solar wind as well as withstand radiation in the earth's "shock bow," the area where the sun's radiation collides with the Earth's magnetic field. MIT scientists, led by **Alan Lazarus**, '53 (VIII), will design and produce two gold-plated sensors called Faraday cups to house BU's sensors. Also participating is **Joseph Binsack**, PhD '66, director of MIT's Center for Space Research. One outcome of Project Wind, say researchers, is that the data measuring how much solar wind is coming from the sun can be used by astronomers to project how long the sun will last.

Professor of Physics **Richard Sorbello**, SM '65, is one of five University of Wisconsin-Milwaukee faculty members named winners of the 1989 Graduate School/UWM Foundation Research Awards. A UWM news release cited Sorbello for his "excellent reputation in both the industrial and academic communities," and his time spent abroad as a visiting scientist. "Known as a first-rate theorist and researcher, he has published more than 60 scientific papers on a variety of subjects including electron and atom transport phenomena, electronic structure of metals, and molecular vibrations at metallic surfaces," it continued. The award winners will each receive a cash award at a ceremony in their honor next fall. . . . **Dave Clark**, PhD '73, a senior research scientist at MIT's Laboratory for Computer Science, is one of four principal instructors this coming October at the INTEROP 89 conference in San Jose, Calif.

MIT Professors **Michael L. Dertouzos**, PhD '64, **Richard K. Lester**, PhD '80, and **Robert M. Solow** are the principal authors of *Made in America: Regaining the Productive Edge* (MIT Press, 1989),

the report of the MIT Commission on Industrial Productivity. (See the four articles in this issue of *Tech Review* for an in-depth look at the topic.) . . . MIT's Clarence J. Lebel Professor of Electrical Engineering **Kenneth Noble Stevens**, ScD '52, has been recently elected a Fellow of the American Academy of Arts and Sciences.

The Institute of Electrical and Electronics Engineers has chosen **Jose B. Cruz, Jr.**, SM '56, to receive its 1989 Richard M. Emberson Award. Cruz, professor and chair of the Department of Electrical Engineering at the University of California, Irvine, was cited for "strengthening Society service in the IEEE, the development of Institute publications programs, and the delivery of control systems technology to members."

The Alumni Association has been notified of the death of **Isaac Goodbar**, SM '45, on April 13, 1989. He was born and raised in Buenos Aires, Argentina, and lived there for the ten years immediately following his graduation from MIT, before returning permanently to the United States. His chief area of expertise was lighting calculation and design, and he was responsible for numerous advances in the field.

VI-A INTERNSHIP PROGRAM

The end of the spring term, as this is being written, brings the culmination of many things: the success of reaching graduation; the success of being the one out of two selected for the new VI-A class; the honor of being an award recipient; and the rite of passage into the "real world" with a challenge to accomplish new things in life. Presented here is much evidence that many of our VI-A's have reached these points this year.

The eighty students who make up the seventy-second VI-A Class have been selected from among those 154 who applied (i.e. 52 percent). The 154 represent 63.1 percent of Course VI sophomores, or the second highest application rate in VI-A history (the highest was in 1983 when 63.7 percent applied); an indication of the Program's continued high acceptance among EECS students. The new students will be well into their first company assignments when you read this. Company participation is stable, this year, with no new firms joining the Program.

This year's list of VI-A's receiving honors and awards is especially impressive. MIT's Annual Awards Convocation saw Professor **Markus Zahn**, ScD '70, honored with a Teaching Award from the Graduate Student Council.

At the annual departmental spring social, awards for outstanding undergraduate teaching went to VI-A's as follows: Carlton E. Tucker Teaching Award to **Salman Ahmad**; Harold L. Hazen Award to **Theodore M. Bloomstein**; and a Special Teaching & Service Award to **Luis H. Rodriguez** for exemplary work with the revised 6.001, Fall '88 and Spring '89.

In the School of Engineering, of the three Henry Ford II Scholar Awards (\$5,000 each) one went to **Jeffrey C. Gealow** and another to **Amy W. Lim**; the awardees are seniors who attained the highest academic records in their third year and "who have exceptional potential for leadership in the profession of engineering and in society." Jeff served as an officer of MIT's Tau Beta Pi chapter this year.

Of the 24 Writing Prize awards sponsored by MIT's Writing Program, one went to **Robert D. Duis** and one to **Michael M. Goodwin**. This field ranged from poetry to scientific and technical communications.

Director of Athletics Royce Flippin, in announcing the athletic awards, termed this "an extraordinary year" in the athletic program. Several national champions headed the list. '88-'89 also saw the greatest number of straight "T" awards, MIT's highest award for athletic excellence of which two VI-A's were recipients: **Timothy J. Sulzbach**—Eastern Intercollegiate Ski Association Division II cross-country relay champion; and **Kai-Yee Ho**—who qualified for the NCAA Division III championship tennis tournament.

The Henry Ford of Solar Cars

By John Mattill

If you think the spirit of gung-ho entrepreneurship is obsolete among young Americans, take another look. Specifically, look at James Worden, '89.

In the five years since his senior year in high school, Worden has built five solar-powered automobiles. For four years he commuted to MIT classes from Arlington, Mass., in *Solectria 2*, his second solar-powered car.

While majoring in mechanical engineering, Worden catalyzed an MIT student team and raised money (chiefly from Dow Chemical Co.) and materials to build three solar-powered cars in the *Solectria* series and race them in Australia, Switzerland (twice), California, and New England. As the team solved the technical challenges of this new technology, the results improved: ninth in the 1987 World Solar Challenge in Australia, sixth in the 1988 Swiss Tour de Sol, first among solar cars in the 1988 International Human-Powered Vehicle Speed Championships (162 miles at 55 mph average) in California, and first in the 1989 American Tour de Sol from Montpelier, Vt., to Cambridge last May.

And when interviewed the week after graduation, Worden outlined an agenda that would leave anyone breathless:

- Rebuild *Solectria 5* and race it in the 1989 Swiss Tour de Sol at the end of June.

- Finish a totally new car, *Solectria Galaxy*, a \$150,000 aerodynamic tour de force, in time to compete for the world solar-powered speed record in Arizona in July.

- Try for a transcontinental solar-powered speed record in *Galaxy*, driving across the country from Los Angeles to Washington in August.

- Design a two-passenger aerodynamic solar-powered sports car to complement a redesigned *Solectria 2*



James Worden, '89, arrived at Commencement the same way he'd commuted to MIT for four years—in his solar-powered Solectria 2. His Solectron Corp. aims to commercialize solar-car technology and market commuter and sports models by 1991.

commuter car, and build pilot models of both cars before 1990.

- With help from fiancée Anita Rajan, '90, organize and finance Solectron Corp. to build the two solar cars for the American market by 1991.

- Earn a master's degree in mechanical engineering in June 1990.

Worden's solar cars are exquisitely simple in concept. Solar cells on the roof—or (in the racing cars) on a horizontal panel through which the driver's head protrudes—charge batteries from which an electric motor draws current to move the car. Regenerative braking adds energy to the system every time the brakes are used. A day's sunshine gives the commuter car two kilowatt-hours of energy—enough to go 50 miles at 35 mph; the sports car will have more solar cells and a five kilowatt-hour capacity, giving it a range of 100 to 200 miles.

If the distances sound modest, keep in mind that the average American's commute is 10 miles, according to Worden. "And if you're sitting in a traffic jam in the sun, this car isn't using power, it's gaining power," Worden told nationally syndicated columnist Ellen Goodman last spring. "There's no pollution, no noise," he says. "That's the

most amazing part."

Hand-made in small numbers, the commuter car would cost about as much as a Hyundai; mass-produced, half that. Prototypes of the sports car (200-mile range, top speed 60 mph) might go for \$15,000. But the owners will never pay for fuel.

"What are the problems, as you think about how to pursue this vision?" I asked Worden. Not the technology, he said. The toughest technical problem—the control system—has been reduced to a half-cubic-foot-sized box of solid-state circuitry by the team's electronics expert, graduate student Gill Pratt. The new *Solectrias* are

powered by three-phase brushless synchronous motors. The team is still experimenting with advanced composites, steel, and aluminum to find the perfect combination of light weight and strength.

Worden's real headaches come from organization: how to manage his and others' time to get the job done. But Mechanical Engineering Professor Harry West, PhD'88, has no doubts that Worden will accomplish what he's set out to do. West is one of the young engineer's strongest supporters, calling him "the Henry Ford of solar cars." Worden himself calls the solar car "a space-age form of transportation to change the world."

Worden's vision captured Ellen Goodman. "To those who have become dubious about the trade-offs of science, cynical about progress, sure that there is a price to be paid for every advance," Goodman wrote in her column, "the James Wordens of the world are as refreshing as a commencement day. He is one of the breed of high-tech environmentalists, people who don't think we have to choose between modern life and the ozone layer." □

JOHN MATTILL is editor emeritus of Technology Review.

Double major **Christopher R. Doerr** (VI-A & XVI) received the Admiral Luis de Florez Prize from Course XVI for undergraduates showing "original thinking or ingenuity." He was a co-partner in the design, construction, and testing of a high-sensitivity infrared thermal detector for gliders.

MIT's Japan Science & Technology Program has been cited by the U.S. Congressional Office of Technology Assessment as a "model for exposing young scientists and engineers to Japanese research, development and manufacturing methods." A VI-A participant in that Program was **Peter A. Schindler**, SM '89, who, through IBM, had assignments at their Tokyo Research Center.

In another business-related area, the Leaders for Manufacturing course recently honored nineteen MIT faculty, among them Professor of Management Science and Information Technology **Stuart E. Madnick**, PhD '72, who heads the School of Management's Information Technologies courses. Stu is also the owner of an English castle hotel of which his son is managing director.

MIT's Tau Beta Pi chapter has a new president for academic '89-'90. He is **Joseph R. Babiec, Jr.**, who was also elected president of the incoming senior class. Another VI-A, **David S. Miller**, will serve as the Chapter's cataloguer.

Richard D. Wesel, who served as Tau Beta Pi president '87-'88 and who graduates this June, plans to join AT&T Bell Labs following a summer vacation at home in Ohio. Bell Labs was his VI-A company.

MIT's chapter of Eta Kappa Nu, national electrical engineering honor society, this spring initiated sixty-one new members—24 of whom were VI-A's. Seven of the 10 newly elected chapter officers for '89-'90 are VI-A's: President **Jeffrey P. Applebaum**; Vice President **Kelly M. Savage**; Treasurer **Kenneth B. Streeter**; Corresponding Secretary **Lisa Su**; and Members-at-Large **Michael P. Niles**, **Todd C. Weigandt**, and **Vincent W. Wong**.

VI-A's astronaut, **William B. Lenoir**, PhD '65, has been selected by Admiral R. H. Truly (acting administrator of NASA) to head NASA's Space Station Program. Your correspondent has a beautiful color photo on his wall, signed by Bill, of the lift-off of his voyage on Columbia. This was presented on the occasion of Bill's talk about the flight at MIT sponsored by the Tau Beta Pi Chapter.

A correction to a notice appearing in the May/June 1989 issue of *Technology Review*: it was **Stewart** (not **Steward**) **E. Miller**, SM '41, who was awarded the Optical Society of America's 1989 John Tyndall Award for distinguished contributions to fiber optics technology. Mr. Miller was formerly director of lightwave telecommunications research at AT&T Bell Laboratories.

A notice in the *Wellesley, Mass.*, paper informs us of the passing of **Wilbert M. Gilman**, '24. He was 86 at the time of his death.

Soloist at an April concert of the MIT Symphony was pianist **Ruth (Shyu) Schindler**, SM '88 (yes, wife of Peter Schindler mentioned above).

The Spring '89 VLSI Review, at MIT, found several VI-A's participating: **John R. English**, SM '84, with Polaroid Corp./Cambridge; **Scott C. Munroe**, SM '77, of Lincoln Labs.; **Shujaat Nadeem**, grad student who presented a paper; and **Thomas R. Shipley**, SM '87, with DEC/Hudson are the ones I met.

Other alumni contacts have included: **Allen J. Baum**, SM '74, who came to the office while he was east for a computer conference; **Eric D. Black**, SM '81, who called from Logan airport on his way back to Calif.; **Leland B. Jackson**, SM '63 (and wife Diana), who came in especially for a visit and reunion with your correspondent—he's a professor at the University of Rhode Island and gave me a copy of his new book on digital signal processing; and **Paul C. Huang**, SM '87, from N.J.—John A. Tucker, Special Assistant to the Department Head for VI-A, MIT, Room 38-473, Cambridge, MA 02139

VII BIOLOGY

MIT Professor of Biology **Robert Allan Weinberg**, PhD '69, has been recently elected a Fellow of the American Academy of Arts and Sciences. . . . **Gwen G. Krivi**, PhD '78, has been named a Senior Fellow in Monsanto Co.'s program to recognize "those individuals making significant, continuing technical contributions to the company and to their specific disciplines." A biochemist in Monsanto's Biological Sciences Department, she was recognized for her achievements in the areas of animal science and human health care. Cited in particular were her "ongoing contributions . . . to the company's programs for bovine somatotropin and porcine somatotropin." . . . **Alan C. Spradling**, PhD '75, was recently elected a member of the National Academy of Sciences. He is a staff member in the embryology department at the Carnegie Institution of Washington, and professor of biology at The Johns Hopkins University. . . . Whitehead Institute for Biomedical Research Director **David Baltimore**, '61, has been elected to succeed Lewis Thomas as chairman of the Scientists' Institute for Public Information. SIPI is a non-profit organization that works to make science and scientists more accessible to the print and broadcast media.

VIII PHYSICS

Former CEO of Hughes Aircraft **Albert Wheelon**, PhD '52, a visiting professor of science, technology, and policy in MIT's Program in Science, Technology, and Society, delivered four lectures this spring on the policy, economics, and technology of space programs. His topics were "The Rocky Road to Satellite Communications," "Getting into Space: Rockets and Shuttles," "Space Commercialization: Myth and Reality," and "Struggling to Make Space Policy." . . . Course VIII alumni involved in "Panic XII"—the International Conference on Particles and Nuclei to be held at MIT in June 1990 include **Mahir S. Hussein**, PhD '71, **John D. Walecka**, PhD '58, and Conference Co-Chairman/MIT Professor **Arthur K. Kerman**, PhD '53. Other Departmental participants are Professor **Ernest J. Moniz**, conference co-chairman, and Institute Professor Emeritus **Victor F. Weisskopf**, honorary chairman.

Harvard Professor **Michael Tinkham**, PhD '54, is a member of the Technical Advisory Board and one of a number of MIT alumni at the American Superconductor Corp. of Cambridge, founded in the spring of 1987. The company has exclusive licenses from MIT and Argonne National Laboratories to several proprietary processing technologies for the new high-temperature superconductors.

Newly elected members of the National Academy of Sciences include: **George B. Field**, '51, Smithsonian Senior Scientist and Robert Wheeler Wilson Professor at Harvard; **Alan H. Guth**, PhD '72, professor of physics at MIT and the Smithsonian Center for Astrophysics; and **Stephen J. Lip-pard**, PhD '65, MIT professor of chemistry. . . . **Ronnie D. Lipschutz**, SM '78, is the author of *When Nations Clash: Raw Materials, Ideology, and Foreign Policy* (Ballinger, 1989). The foreword is written by John P. Holdren, 'SM 66 (XVI), professor and vice-chair of the Energy and Resources Group at the University of California, Berkeley. . . . **Elliott C. Levinthal**, SM '43, of the Stanford Institute for Manufacturing and Automation is a member of the National Research Council's newly reorganized Space Studies Board.

Word has reached the Alumni Association of the deaths of **Michael Addleman**, SM '78, in February 1989; University of Notre Dame Professor Emeritus **Alexander A. Petruskas**, PhD '41, on February 25, 1989; and **Bruce S. McClain**, PhD '83, formerly of the University of Utah's Department of Physics, in 1988. No further information was provided.

X CHEMICAL ENGINEERING

Gary P. Stern, SM '66, formerly senior vice-president at U.S. Leasing International, Inc. (a subsidiary of Ford Motor Co.) is now the President of Airlease Ltd. in San Mateo, Calif. . . . **W. Henry Tucker**, ScD '47, of Riverside, Calif., is president of the Southern California Friends of World Neighbors, an international self-help organization. . . . **Manfred Gans**, SM '51, writes: "My latest activity on behalf of the United Nations Development Program has brought me to Pakistan, where we are likely to set up another Applied Research Institute for the refinery and emerging petrochemical industry. Our company, TEDA, is keeping busy with more locally oriented problems. . . . **A.E. Stancell**, ScD '62, is now vice-president for Mobil Oil's European Exploration and Producing business, following his recent job as vice-president for U.S. Exploration and Producing.

Murray W. Rosenthal, ScD '53, has been appointed deputy director of the U.S. Department of Energy's Oak Ridge National Laboratory. . . . **Francis R. Russell**, ScD '36, retired in 1971 from Exxon Research and Engineering. He taught five science subjects for three years at the local vocational/technical school, and is an NRA rifle instructor (for the Boy Scouts) and NRA self-defense instructor. He has a 50-foot, police-approved shooting range in his home. Russell and his wife celebrated their 50th anniversary in 1988 by visiting Alaska; they have five children and nine grandchildren. . . . **John E. Anderson**, ScD '55, senior corporate fellow and a leading researcher in high temperature combustion technology at Union Carbide Industrial Gases, Inc., received the Inventor of the Year Award from the New York Patent, Trademark, and Copyright Law Association, Inc. He was recognized for "his contribution to Union Carbide's 'A' Burner, a combustion system for high-temperature furnaces that permits use of pure oxygen in place of air to reduce energy consumption while minimizing pollution."

XI URBAN STUDIES AND PLANNING

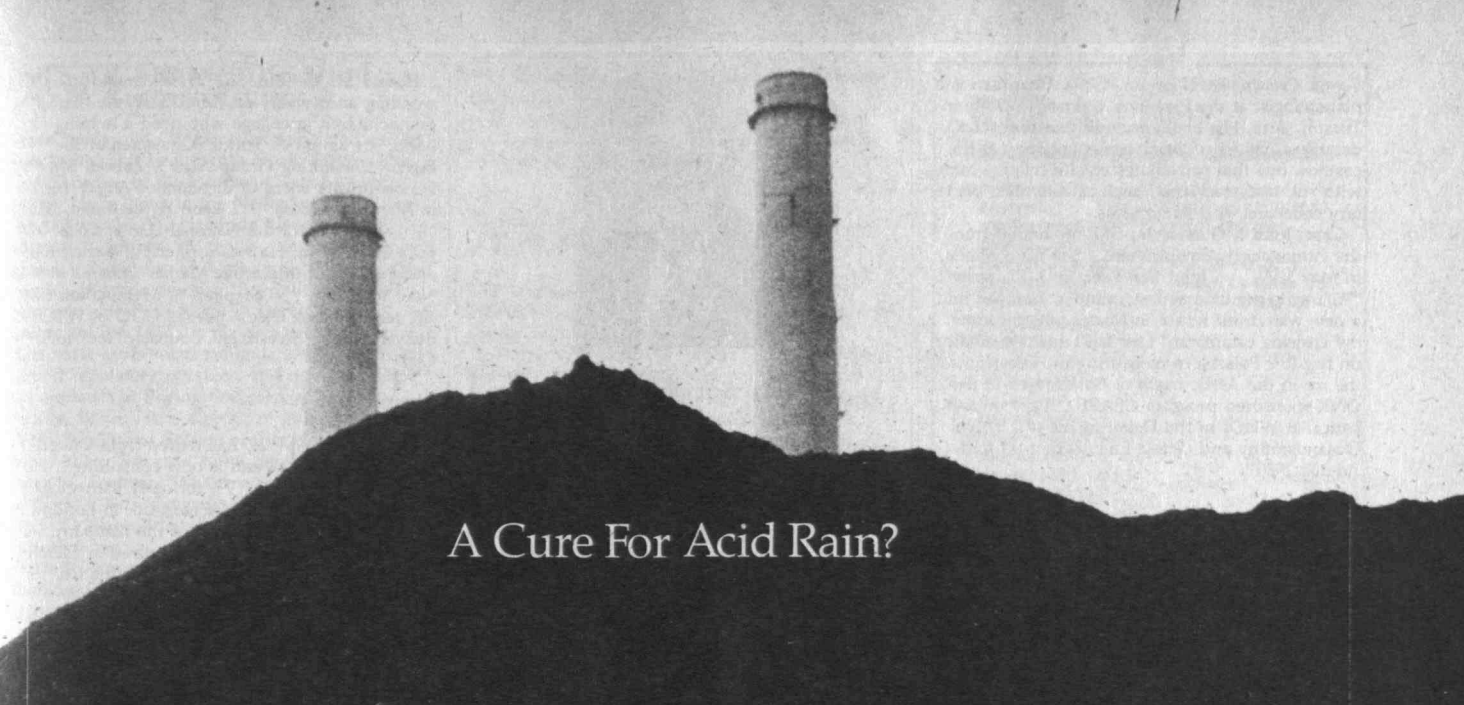
Ira Haironson, MCP '85, reports that he has been at the N.Y.C. Transit Authority for the last two years. "It is exciting to see the day-to-day improvements," he says. "Our job is to make this the best subway in the world."

Scott A. Cassel, MCP '88, is involved in long-range planning for the Massachusetts Water Resources Authority.

James E. Wallace, PhD '72, was the 1987-88 technical director of the National Low Income Housing Preservation Commission. . . . Former Mayor of San Antonio **Henry G. Cisneros**, '74, is now chairman of the Cisneros Group in San Antonio.

XII EARTH, ATMOSPHERIC, AND PLANETARY SCIENCES

MIT Professor of Meteorology **Edward N. Lorenz**, ScD '48, has received the Elliot Cresson Medal from the Franklin Institute for his pioneering work in the study of chaos. "In the course of his work on weather systems," said the news release, "Dr. Lorenz found that he was getting chaotic results from some of his calculations. Convinced that these inconsistencies were not caused by faulty data or computer errors, Dr. Lorenz began to study chaos itself. His early insights, published in his 1963 paper 'Deterministic Nonperiodic Flow,' marked the beginning of a new field of study. Some scientists have asserted that the twentieth century will be remembered for three scientific revolutions—relativity, quantum mechanics, and chaos." . . . **Clark R. Chapman**, PhD '72, is the co-author along with David Morrison of



A Cure For Acid Rain?

With the advent of the Bush administration, the United States finally may take action on its festering acid-rain problem, but researchers at MIT's Energy Laboratory think the most effective solution still is being ignored.

The approach that seems to be gathering momentum—a nationwide requirement to slash sulfur emissions by installing expensive pollution-control devices at power plants and other industrial facilities—isn't cost effective, they have concluded. Rather, switching some plants from coal and oil to natural gas during the summer months would slash acid rain as effectively and cost far less, according to Dan Golomb, Gary Galeucia, SM '86, and James A. Fay, SM '47, of the Energy Laboratory.

Acid rain—more accurately called “acid deposition,” because the problem includes dry forms of acid as well as acid snow—is thought to be wreaking environmental havoc in parts of Canada and the northeastern United States, such as the Adirondack Mountains. The phenomenon has been linked to sulfur dioxide and nitrogen oxides from the burning of fossil fuels in automobiles and in industrial plants, particularly in the Midwest. Most proponents of controlling acid rain, such as Maine Senator George Mitchell, believe that nationwide limits on emissions of pollutants would solve the acid rain problem.

But to develop an alternative to that scattershot approach, Golomb and his colleagues studied in detail how pollu-

tion originating in 31 states from Missouri eastward gives rise to acid rain at one test site in the Adirondacks that is typical of the whole Northeast. Using models of how the pollution is transported through the atmosphere, the trio found that the bulk of the Adirondacks' acid rain comes from a handful of midwestern states. Although other states may dump much pollution into the air, it has little impact—for example, it may blow out to sea or chemically decompose before reaching the Adirondacks. Moreover, researchers also have found that most acid rain falls during April through September.

Thus, the Energy Laboratory researchers concluded that the best way to attack acid rain would be substituting low-sulfur natural gas for high-sulfur coal and oil in the problem areas during April through September. Although natural gas is a more expensive fuel, the MIT strategy would avoid the need for expensive scrubbers for burning high-sulfur fuels. As long as the difference in the price of coal and natural gas, per million BTU of energy, is less than the cost of installing and operating scrubbers, the seasonal strategy will be cost-effective.

Moreover, burning natural gas produces no slag or soot, thus reducing waste disposal problems, Golomb said. And plant operators could use the summer for maintenance and repairs on pollution-control equipment not needed for gas but needed for the coal and oil.

“This is an interesting strategy,” said Rod Fujita of the Environmental

Defense Fund in New York City, which generally endorses making greater use of natural gas. The EDF sees natural gas both as a solution for acid rain and as a fuel that releases less carbon, which has been implicated in the “greenhouse effect.” But regardless of its scientific wisdom, Fujita said, the Energy Laboratory proposal may well be politically unsalable, because of fears it would hurt the economies of the Midwest's coal-producing states.

Indeed, policymakers have shown little interest in the MIT conclusions. “It's been like hollering into a big void,” Golomb said. Part of the problem, he believes, may be an attitude that nationwide emissions standards are the fairest approach, even if they are not the most environmentally effective method. That view certainly seems uppermost in the minds of legislators who will have to craft a policy for dealing with acid rain and other issues of air pollution.

“The universality of the threat dictates that solutions must be broadly based,” Senate Majority Leader Mitchell recently said in a Senate speech on air pollution. “A policy that imposes huge job losses in West Virginia or Ohio or Kentucky or Illinois is no more acceptable than a policy that imposes heavy pollution damage on Maine or Vermont or North Carolina.”—*Vincent Kiernan* □

VINCENT KIERNAN spent this past year at MIT as a Knight Fellow in Science Journalism. He is a science writer for the Alameda Newspapers in California.

Cosmic Catastrophes (Plenum, 1989). Chapman is a planetologist at the Planetary Science Institute in Tucson, Ariz. His book, according to the jacket, describes "evidence for an emerging view of the cosmos, one that punctuates eras of relative calm with sudden cataclysms" such as asteroids, planetary collisions, and supernovas.

Capt. **John J. Owens, Jr.**, SM '66, retired from the Atmospheric Environmental Service (Canada) in May 1979. . . . **John Van Leer**, ScD '71, writes: "Following my divorce last summer, I moved into a new waterfront house in Miami where I moor my cruising catamaran. Last fall I spent 4 months on the R/V Polarbjorn measuring the ocean under the ice in the Arctic north of Spitsbergen in the ONR-sponsored program CEAREX. I am on sabbatical at WHOI in the Departments of Physical Oceanography and Ocean Engineering till mid-August 1989."

XIII OCEAN ENGINEERING

Capt. **Robert L. Evans**, SM '37, is the State of New Hampshire coordinator for the *Math Counts* program. . . . Vice Adm. **C. Russell Bryan**, NE '52, USN (ret), was appointed by the secretary of transportation to be the chairman of the Advisory Committee to the U.S. Coast Guard Academy. . . . Coast Guard Lt. **Kevin Carpentier**, SM '82, recently completed a six-week law enforcement patrol in the Caribbean Sea. During the patrol aboard the cutter *Tahoma*, he participated in the rescue of a crew of five aboard a disabled 74-foot fishing vessel, and seized a 65-foot stateless fishing vessel carrying 16,000 pounds of marijuana. . . . Navy Lt. **Kevin J. Fox**, SM '83, recently participated in the NATO exercise "Wintex '89" while serving with the commander-in-chief of U.S. Naval forces in Europe, London, and the United Kingdom.

Capt. **George C. Wells**, SM '39, USN (ret), died on April 2, 1989, in Middletown, R.I. Wells' naval career spanned 32 years until his retirement in 1966. He was awarded a Bronze Star for his work as design superintendent at the Pearl Harbor naval yard from 1943 to 1945. After retiring from the service, he was an advisor for 10 years to the Shipbuilders Council of America in Washington, D.C. . . . The Alumni Association has been notified that Capt. **Oscar M. Browne, Jr.**, SM '35, died on April 19, 1989. No further information was provided.

XIV ECONOMICS

Arnold R. Weber, PhD '58, president of Northwestern University, has been named a director of the Tribune Company in Chicago. . . . **Scott E. Pardee**, PhD '62, has moved up from vice-chairman to co-chairman of Yamaichi International (America) Inc., a U.S. subsidiary of Yamaichi Securities Co. of Tokyo. . . . Former Secretary of State **George P. Shultz**, PhD '49, is now chairman of the International Council of the Morgan Guaranty Trust Co., a subsidiary of J.P. Morgan & Co. . . . **Fred A. Mudgett**, SM '43, has retired as president and CEO of Rent-A-Wreck of America, Inc. in Los Angeles; he will continue to serve as a consultant.

Eric B. Rasmusen, PhD '84, is the author of *Games and Information*, a book on game theory published by Basil Blackwell.

Andrei Shleifer, PhD '86, has been chosen to receive a Presidential Young Investigator Award from the NSF. An assistant professor in the University of Chicago's Graduate School of Business, Shleifer is an economist with a special interest in mergers and acquisitions. With a colleague, he has shown that targets of hostile takeovers are not just poorly performing businesses, but tend to be in industries that are themselves in decline. He has also studied the relation between management ownership and mar-



R.J. Schwinghamer

ket valuation and various aspects of industrial development. . . . **Kenneth S. Flamm**, PhD '79, is the co-author (with Robert W. Crandall) of *Changing the Rules: Technological Change, International Competition, and Regulation in Communications* (The Brookings Institution, 1989). Flamm is a senior fellow in the Brookings Foreign Policy Studies program.

XV MANAGEMENT

Bernard R. Horn, Jr., SM '80, "is a principal of Horn & Co., an investment counselling firm helping individuals, trusts, and tax-qualified accounts achieve their investment goals with a global investment philosophy executed under strict value criteria," he writes. "Horn & Co. is currently forming a pooled investment fund to invest in a portfolio of globally diversified securities." . . . **Bruce D. Werner**, SM '86, has joined the R.D. Werner Co., Inc., as fiberglass manager and is responsible for all composite operations. He lives in downtown Chicago. . . . From Switzerland, **Gary B. Galeucia**, SM '86, writes that he has transferred to DuPont's Geneva office. He and his wife, Monica, are expecting a baby in November. . . . Since January, **Thomas P. Caruso**, S.M.'84, has been a quality assurance specialist (a software engineering position) with the National Computer Systems, Inc., that markets software to the mutual fund industry. Before that he worked for three and a half years as a business development consultant to start-up companies in the pharmaceutical, health, medical, telecommunications, and software industries. . . . For 1988-89, **John R.M. Gordon**, PhD '66, is a visiting professor of management at Stanford University's Graduate School of Business. He is on leave from Queen's University in Kingston, Ontario.

Eleanor Dorn Phillips, SM '77, reports that she has developed a materials organization in Digital Equipment Corp. that "determines total materials strategies and assures their implementation for product introductions and retirement. Vicariously participating in husband's start-up business manufacturing polarizers, now completing third year." . . . **James B. Edgerly**, SM '83, has recently returned from seven weeks in the People's Republic of Mozambique, where he was working on a World Bank-funded project to restructure 10 major industrial companies. Representing Arthur D. Little (where he is in his sixth year) he led a team of seven consultants and engineers. His third child was due in June.

Arun Lyng, SM '86, writes: "My wife, Amelia, and I are still living in Connecticut. Over the past three years we have been busy restoring our 100-year-old Victorian house. We also have a beautiful 10-month-old baby boy, Aleksander Matias, who is taking up all our time. Besides this I work for Aetna Bond Investors, where I am in charge of the research and development unit, a job I enjoy very much." . . . **Judith A.F. Gilman**, SM '81, continues to work with her husband, Carl Schwenk, in consulting to NASA. Her most recent accomplishment, she reports, is the publication of an assessment of NASA's Small Business Innovation Research Program.

Harold M. Weddle, SM '29, celebrated his 57th wedding anniversary on June 23. "Have five grandchildren in college who need a helping hand," he says. . . . Former Chairman of the Boston Consulting Group **Alan J. Zakon**, SM '59, is now on the board of directors of Augat, Inc., in Mansfield, Mass. . . . **Leon H. Liebman**, SM '67, is chairman of the National Digital Corp. in Falls Church, Va. He was formerly the chairman and founder of Interactive Market Systems in New York City. . . . **Stephen E. Memishian**, SM '70, recently took a new post as COO of W.P. Stewart & Co., Investment Counsel, New York City.

Sloan Fellows

Hugh E. Witt, SM '57, has retired from United Technologies Corp., and is now consulting. . . . **Robert B. Horton**, SM '71, formerly managing director of the British Petroleum Co. in London, is now the deputy chairman of the company. . . . **Russell C. Youngdahl**, SM '63, retired in March as president of the Long Island Lighting Co. . . . Moving up from his former position as vice-president and general manager of Rorer Hospital Products (a subsidiary of Rorer Group, Inc.), **Joseph J. Beshel**, SM '82, has become senior vice-president and general manager of Rorer Consumer Pharmaceuticals (another subsidiary of Rorer Group). . . . Formerly senior vice-president of marketing at the BellSouth Corp., **Jere A. Drummond**, SM '79, is now executive vice-president of marketing, network, and planning at a BellSouth subsidiary, BellSouth Services, Inc. He succeeds **Floyd Duane Ackerman**, SM '78, who has become vice-chairman of the BellSouth Corp. . . . **William Clay Ford, Jr.**, SM '84, has moved from being chairman and managing director of Ford Motor Co. S.A. in Zurich, Switzerland, to being manager of heavy truck engineering and manufacturing at the Ford Motor Co. in Louisville, Kentucky. . . . **Donald V. Fites**, SM '71, has advanced from executive vice-president of Caterpillar, Inc., to president and COO.

Robert J. Schwinghamer, SM '68, has received the NASA Outstanding Leadership Medal. He was one of 225 people honored for their role in America's successful return to space with the flight of Space Shuttle *Discovery* in September 1988. Schwinghamer is the deputy director of Space Transportation Systems in the Science and Engineering Directorate and director of the Materials and Processes Laboratory at the Marshall Space Flight Center in Huntsville, Ala. . . . Professor **George W. Morgenthaler**, SM '70, chairman of the University of Colorado's Department of Aerospace Engineering and associate dean for research in its College of Engineering and Applied Science, is a member of the National Research Council's newly reorganized Aeronautics and Space Engineering Board.

William J. Stolze, SM '60, is the author of *Startup: An Entrepreneur's Guide to Launching & Managing a New Venture* (Rock Beach Press, 1989). A sample testimonial blurb from Louise Woerner, founder and president of HCR Rochester: "Startup was particularly helpful to me. The popular books on entrepreneurship written in the past decade neither cover particular business issues entrepreneurs face as clearly, nor offer as useful examples. By virtue of this text, Bill Stolze becomes a generous colleague offering insights to those who might not otherwise be aware of key opportunities and pitfalls of business ownership."

Senior Executives

Andre Gillet, '68, has recently retired as chairman of International Multifoods Corp. in Minneapolis. . . . **George T. Richardson**, '75, the retired chairman of Sonat Offshore Drilling Co., has been named a director of Global Marine, Inc., Houston.

XVI AERONAUTICS AND ASTRONAUTICS

Steve Brody, SM '77, has been appointed as NASA's technical liaison for the Space Station Freedom Program to the European Space Agency (ESA). He is living in the Netherlands and working at ESA's ESTEC facility in Noordwijk. . . .

Clinton A. Jeffrey, SM '86, is a propulsion engineer working for Air Canada in Montreal, Quebec. He is currently on a 12-month scholarship program with Rolls-Royce in Derby, England. . . . **Oktay Yesil**, S.M.'70, is the technical leader in airport noise assessment methods, certification and airport regulatory activities, and noise of competitor airplanes at Boeing Commercial Airplanes, Seattle, Wash. He is director of publicity of the Pacific Northwest Section of the AIAA and established of the Section's AIAA display program. . . .

Peter M. Bainum, SM '60, was elected chairman of the IAF Astrodynamics TC in 1988, and re-elected vice-president of the International American Astronautical Society that same year. . . . **Mark E. Brown**, SM '83, works for The Analytic Sciences Corp. (TASC) California systems engineering office. He is working on advanced concepts for acquisition, tracking, and pointing of directed energy weapons for the Strategic Defense Initiative.

Tommy D. Masek, SM '63, is president of Chippewa Traders, Ltd., manufacturer of "Fire-tender/Stokermatic" coal stoker heating equipment for residential and commercial use. . . . **Comdr. James W. Neighbours**, '61, is "now retired and doing considerable volunteer work and traveling. I have been a member of the MIT Educational Council for about 25 years," he writes. . . . Among the members of the National Research Council's newly reorganized Aeronautics and Space Engineering Board: Vice-chair **Eugene E. Covert**, ScD '58, head of MIT's Department of Aeronautics and Astronautics; **Byron K. Lichtenberg**, ScD '79, president of Payload Systems, Inc.; **Robert G. Loewy**, SM '48, institute professor of mechanical and aerospace sciences at Rensselaer Polytechnic Institute; and **Stanley Martin, Jr.**, '52, technical director of the Bell-Boeing Joint Program Office.

XVII POLITICAL SCIENCE

From Bogor, Indonesia, **Russell H. Betts**, PhD '76, writes: "I have recently taken over the post of regional representative (Resident Representative/Indonesia) of the World Wide Fund for Nature. . . . **Ernest H. Evans**, PhD '77, is an assistant professor of political science at Christendom College in Front Royal, Virginia. . . . **Nelle W. Temple**, PhD '80, reports: "I'm working with legislation on foreign assistance and Third World debt on the staff of the Banking Committee of the House of Representatives. Helping good ideas become public policy (and keeping out the bad ones!) uses all the experience and skills I've acquired to date."

XVIII MATHEMATICS

Mark A. Kon, PhD '79 is an associate professor in the math department at Boston University. . . . **Leopold Flatto**, PhD '55, is a mathematician for Bell Laboratories in Murray Hill, N.J., and a mathematics professor at Yeshiva University in New York City. . . . Johns Hopkins University Professor **Robert H. Scanlan**, PhD '43, has been honored several times in the last three years: in 1986, he was awarded the ASCE Wellington Prize and Newmark Medal, in 1987 was elected to the National Academy of Engineering, and in 1988 received the James Cross Medal from the ASCE. . . . **Joe J. Kilian**, PhD '89, and **Christopher R. Stover**, PhD '88, were among the 30 recipients of Mathematical Sciences Postdoctoral Research Fel-

lowships awarded by the Division of Mathematical Sciences of the NSF.

The Alumni Association has been notified of the death of **Murray S. Watkins**, '58, of Ottawa, Ontario, on April 9, 1988.

XXI HUMANITIES

MIT Professors of Linguistics and Philosophy **Kenneth L. Hale** and **Judith J. Thomson** have recently been elected Fellows of the American Academy of Arts and Sciences. . . . A recently-elected member of the National Academy of Sciences is **Barbara H. Partee**, PhD '65, a professor in the Department of Linguistics and Philosophy at the University of Massachusetts, Amherst. . . . **George Lakoff**, '62, professor of linguistics at the University of California, Berkeley, is the co-author, with Mark Turner, of *More than Cool Reason: A Field Guide to Poetic Metaphor* (The University of Chicago Press, 1989). Say the University of Liverpool's Ann Thompson and John O. Thompson in a cover blurb: "The intellectual adventure begun in *Metaphors We Live By* [by the same authors] is here extended with the verve and resourcefulness we'd hoped for. . . . Literary metaphor has never seemed less cut off from the wider world."

XXII NUCLEAR ENGINEERING

Shivagi S. Seth, ScD '70, is lead engineer at MITRE Corp. in McLean, Va., with responsibility for a project to assist the U.S. Nuclear Regulatory Commission in developing regulation for renewal of nuclear plant operating licenses. . . . Since January 1988, **Achilles G. Adamantiades**, PhD '66, has been a senior power engineer in the technical department of the Europe, Middle East, and North Africa region of the World Bank. He has been working mainly on power projects in Pakistan, Jordan, Hungary, and Cyprus. He has taken a leadership role in supporting the introduction of advanced thermal-plant technologies in developing countries, including fluidized-bed boilers and combined-cycle combustion turbines. He is also leading a task force on nuclear power issues. Adamantiades is adjunct professor of mechanical engineering at George Washington University in Washington, D.C. . . . **Joseph P. Kearney**, PhD '73, is now the CEO of a Pacific Gas & Electric joint venture with the Bechtel Group that builds and operates cogeneration and independent power production facilities. He was formerly the chairman and CEO of the Coastal Power Production Corp. . . . **William T. McCormick, Jr.**, PhD '69, the chairman of CMS Energy Corp., has been named a director of Rockwell International Corp.

Emory University Radiology Professor **Roderic I. Pettigrew**, PhD '77, was honored this spring as one of "12 of the nation's most outstanding black male achievers" at Morehouse College. He received the "Bennie" achievement award (named for former Morehouse President Benjamin E. Mays) in recognition of his outstanding work in



R.I. Pettigrew

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Robert H. Noble '76
Don R. Widrig '65

nuclear medicine. After graduating from MIT, where his dissertation research was on the physics and use of boron neutron capture therapy, a radiation therapy technique to treat malignant brain tumors, Pettigrew earned an MD at the University of Miami Medical School in an accelerated two-year program open only to PhDs. At Emory, he has developed and evaluated a method of making movies of the beating heart with startlingly clear detail using magnetic resonance imaging. He is currently on leave to do research on cardiac imaging at Harvard University for a year. . . . **Charles W. Forsberg**, ScD '74, is the program manager for the Developmental Light Water Reactor Program at Oak Ridge National Laboratory. "The DLWR is an advanced reactor concept for use past the year 2000 which meets PRIME (Passive, Resilient operation, Inherent, Malevolence resistance, Extended time) safety goals," he writes.

TPP TECHNOLOGY AND POLICY PROGRAM

Kent W. Hughes, SM '85, writes: "There have been a few changes in my life the last six months: I've changed jobs— am now a member of the scientific staff at Bell Northern Research, Mountain View, Calif. I'm happily married to Debbie Vandegriff (October 8, 1988) and to top it off, we've moved: 3832 Haven Ave., Fremont, CA 94538." . . . **Steven W. Stewart**, SM '85, and wife Julie report that their two-year-old daughter Erin will have a new sibling sometime in June.

Newton de Castro, SM '81, has formed his consulting company, NGT, which works with the World Bank on major Brazilian projects such as the North-South Railroad and the reorganization of state transportation agencies. . . . **Marina Skumanich**, SM '88, is currently working for an environmental policy firm called Hagler Bailly, Inc.

Valerie Pietrzyk, SM '85, has received an MD degree from Dartmouth and will be doing her residency in family practice at Brown University. . . . **Marina Pocaterre**, SM '87, has returned to Venezuela where her husband, Roberto, has accepted an important position with the Venezuelan government.—Richard de Neufville, Chairman, MIT Room E40-252, Cambridge, MA 02139

Deceased

The following deaths have been reported to the Alumni Association since the *Review's* last deadline:

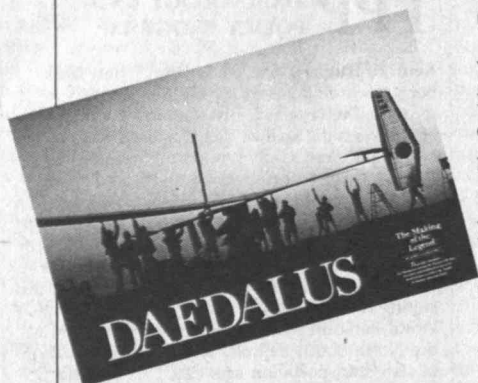
Arthur E. Gilmour, '17; November 24, 1987; Haverhill, Mass.
Howard M. Cyr, '18; April 21, 1989; Palmerton, Penn.
Oscar A. de Lima, '19; November 1987; Stamford, Conn.
Karl D. Bean '20; June 21, 1988; Yarmouthport, Mass.
Percy Bugbee, '20; May 16, 1989; Plymouth, Mass.
Chesterton S. Knight, Sr., '21; May 6, 1989; Brockton, Mass.
A. Alfred Franks, '24; April 6, 1989; Brookline, Mass.
Frank J. Hecht, Jr., '24; June 10, 1988; Tall Timbers, Md.
Richard Lamborn, '24; May 7, 1989; Erie, Penn.
Foster N. Perry, '24; March 23, 1989; Southern Pines, N.C.
Shedd Vandenberg, '25; April 27, 1989; Rancho Santa Fe, Calif.
James L. Suydam, '26; May 8, 1988; Fennville, Mich.
William P. Berkeley, '27; April 8, 1989; Cazenovia, N.Y.
Manuel George Robinson, '27; July 1987; Boston, Mass.
Mrs. Earl J. LeRoi, '29; September 19, 1986; Omaha, Neb.

Murray W. Bulford, '30; April 8, 1989; Yantic, Conn.
Henrik M.C. Luykx, '30; February 28, 1989; Bethesda, Md.
Vincent P. Mango, '31; October 27, 1988; Springfield, Mass.
Sidney G. Albert, '32; February 17, 1989; Clearwater, Fla.
Willard A. Meyer, '32; April 9, 1989; Lincolnville, Maine.
Stanley L. Brown, '33; April 15, 1989; Flicksville, Penn.
Charles S. Reasby, '33; May 30, 1989; Worcester, Mass.
Mrs. Carroll B. Fentress, '34; May 3, 1986; Eugene, Ore.
John M. Hitchcock, '34; May 9, 1989; Southborough, Mass.
Edwin L. Williams, '34; May 31, 1988; Mississauga, Ontario, Canada.
Oscar M. Browne, Jr., '35; April 19, 1989; Seattle, Wash.
John Chapper, '36; April 21, 1989; Swampscott, Mass.
Eugene Paul Johnson, '37; February 23, 1989; Highlands, N.C.
Nicholas L. Barbarossa, '38; September 20, 1988; Williamsburg, Va.
Francis S. Buffington, '38; April 23, 1989; Flintridge, Calif.
Stuart V. Arnold, '39; May 10, 1989; Hingham, Mass.
B. William De Lia, '39; March 3, 1989; Northville, N.Y.

Denys W. Knoll, '39; April 12, 1989; Erie, Penn.
George C. Wells, '39; April 2, 1989; Portsmouth, R.I.
Charles T. Booth, '40; February 21, 1989; Greenville, S.C.
Rafael J. Martinez, '40; April 5, 1989; Guaynabo, P.R.
Joseph L. Shill, '40; April 1, 1989; Canaan, N.Y.
Harry C. Lord, '41; April 29, 1989; Largo, Fla.
Alexander A. Petrauskas, '41; February 25, 1989; South Bend, Ind.
H(enry) Gordon Poole, '41; September 8, 1988; Green Valley, Ariz.
William W. Zimmerman, '42; 1983.
Alfred Stockfleth, '42; June 21, 1988; Wilmington, Del.
Mrs. Ian B. Bennett, '44; December 29, 1988; Irving, Tex.
Isaac Goodbar, '45; April 13, 1989.
Paul F. Murray, '51; April 24, 1989; Watertown, Mass.
Alcon E.J. Gallagher, '53; November 6, 1988; Lakewood, Col.
Neal B. Mitchell, Jr., '59; March 26, 1989; Sudbury, Mass.
Alexander J. Borrevik, '64; September 23, 1982.
Charles F. Bichoff, Jr., '74; April 14, 1989; W. Caldwell, N.J.
Michael Addleman, '78; February 1989; Toronto, Ontario Canada.
Jeff L. McClelland, '80; March 8, 1987; Sedona, Ariz.
Nellie Y. Whetten, '81; March 24, 1989; Fort Collins, Col.

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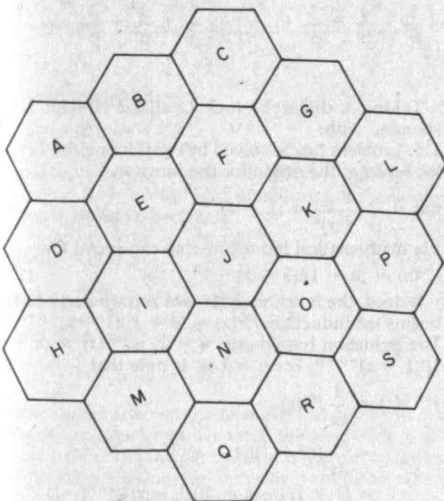
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Hexagony

Pretty exciting times around here. It is Friday and I am leaving on Tuesday for a conference in Israel with a post-conference tour of Egypt. However, I have only "secondhand" hotel confirmations for Israel (i.e., from the arrangement group, not from the hotels themselves), do not even know the name of the hotel in Egypt, and have not received any confirmation about the tour. This is *not* my normal style of travel, but people here tell me not to worry so I am trying not to.

Problems

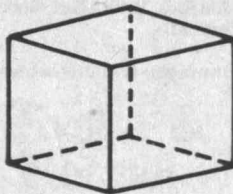
A/S 1. My plea for computer-related problems has inspired Warren Himmelberger. I still need more such problems. Mr. Himmelberger wants us to devise a computer program to use the numbers 1 through 19 once each to label the hexagons below so that each diagonal sums to the same value. Note that there are six diagonals with 3 hexagons each, six with 4, and three with 5.



A/S 2. A magic-square problem from Ronald Martin. He wants you to arrange the numbers from 1 to 121 in an 11 x 11 grid so that all rows, columns, and

diagonals sum to 671. Note that to form most diagonals you must imagine a copy of the square placed next to the original.

A/S 3. Our third problem comes from a 1986 issue of *IEEE Potentials*. According to Dan Benson of the University of Washington, a plane can be found that will divide the cube into two identical halves whose common face is a regular hexagon. He says there are four such planes. How many can you find?



A/S 4. Richard Hess has taken craps to an extreme and writes: In Extreme Craps, four dice are thrown and the middle two dice are ignored. Otherwise, it is played the same as ordinary craps. What is the shooter's probability of winning Extreme Craps?

A/S 5. Frank Rubin tells us about Milo Mindbender, a student at Drudgery High. After every test, Milo figures out his cumulative average, which he always rounds to the nearest whole percent. Today he had two tests. First he got 75 in French, which dropped his average by 1 point. Then he got 83 in History, which lowered his average another two points. What is his average now?

Speed Department

SD 1. Speedy Jim Landau wants to know what happens when an irresistible force encounters an immovable object.

SD 2. Mark Astolfi has a five-card poker hand with exactly one wild card. Which two standard poker hands are impossible?

Solutions

APR 1. Our first problem, from Nob. Yoshigahara, involves multiplying a "time expression," i.e., one involving hours, minutes, and seconds by a scalar to obtain another time expression. Another requirement is that all ten digits are to be used once each. $ab:cd \times e = fgh:i:j$.

Steve Feldman says that he is sure he has seen (and solved) this problem sometime within the past few years but adds that he is not complaining. With a little help from a BASIC program Mr. Feldman found the correct answer

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10012.



50:42 × 9 = 7:36:18.

Also solved by Robert Bart, John Chandler, Gordon Rice, Harry Zaremba, Richard Hess, Matthew Fountain, and the proposer.

APR 2. William Pulver knows twelve golfers who play weekly in 3 foursomes, 2 players as a team in each foursome competing against the other pair in that foursome. The problem is to arrange a schedule so that each golfer plays with each of the other eleven the same number of times and against each of the eleven the same number of times.

The following solution is from Matthew Fountain: The schedule below is satisfactory.

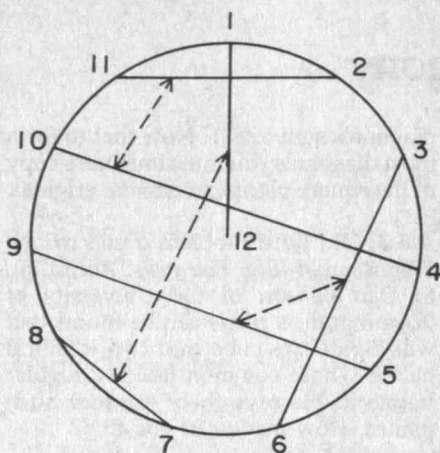
1,12- 7,8	2,11- 4,10	5,9 - 3,6
2,12- 8,9	3,1 - 5,11	6,10- 4,7
3,12- 9,10	4,2 - 6,1	7,11- 5,8
4,12-10,11	5,3 - 7,2	8,1 - 6,9
5,12-11,1	6,4 - 8,3	9,2 - 7,10
6,12- 1,2	7,5 - 9,4	10,3 - 8,11
7,12- 2,3	8,6 -10,5	11,4 - 9,1
8,12- 3,4	9,7 -11,6	1,5 -10,2
9,12- 4,5	10,8 - 1,7	2,6 -11,3
10,12- 5,6	11,9 - 2,8	3,7 - 1,4
11,12- 6,8	1,10- 3,9	4,8 - 2,5

Each line of the schedule represents the pairings for one weekend.

The schedule is compiled by use of the accompanying diagram. Each line on the face of the circle connects two players who are partners the first weekend. Pairs of lines determine the foursomes. The pairings for the second weekend are found by rotating each number on the circumference to the next position on the circumference. Pairings for the following weekend are found by repeating this process. As none of the chords on the circle are the same length, each rotation results in pairings that do not duplicate any previous pairing.

The dotted lines indicate the two partner pairs that form a foursome. If all mutual opponents on the circumference were to be joined by lines, the ten new chords formed would be of five different lengths, two chords of each length. The first weekend the players joined by these chords would be 1-7, 1-8, 2-4, 2-10, 11-4, 11-10, 5-3, 5-6, 9-3, and 9-6. Thus as the players rotate through all the posi-

tions on the circumference they each play each other twice as opponents.



Also solved by Gordon Rice, Robert Bart, Robert Roth, and Winslow Hartford.

APR 3. Matt Stenzel wants you to show that for $p = 2, 3, 4, \dots$

$$\sum_{n=1}^{\infty} \frac{1}{p^{n+1}}$$

is a perfect square.

I am printing two rather different solutions. Phylis Savari writes:

$$\sum_{n=1}^{\infty} \frac{1}{p^{n+1}} = \frac{1}{p^2} + \frac{1}{p^3} + \frac{1}{p^4} + \frac{1}{p^5} + \dots$$

$$= \left(\frac{1}{p^2} + \frac{1}{p^3} + \frac{1}{p^4} + \dots \right) + \left(\frac{1}{p^3} + \frac{1}{p^4} + \frac{1}{p^5} + \dots \right) + \left(\frac{1}{p^4} + \frac{1}{p^5} + \frac{1}{p^6} + \dots \right) + \left(\frac{1}{p^5} + \frac{1}{p^6} + \frac{1}{p^7} + \dots \right) + \dots$$

and since an infinite geometric series with ratio r ($|r| < 1$) and first term a_1 is equal to

$$\frac{a_1}{1-r},$$

we can rewrite the above expression as

$$\frac{1}{p(p-1)} + \frac{1}{p^2(p-1)} + \frac{1}{p^3(p-1)} + \frac{1}{p^4(p-1)} + \dots$$

we can apply

$$S = \frac{a_1}{1-r}$$

to this expression now and find that the sum of the terms in the denominator =

$$\frac{1}{p(p-1)} = \frac{1}{(p-1)^2}$$

(This is why p was constrained to 2, 3, 4, ...)

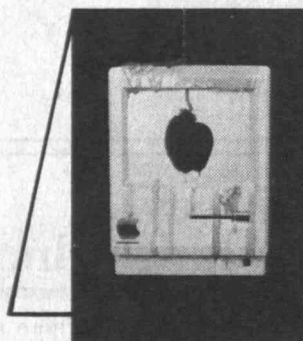
$$\text{If } p = 1, \frac{1}{(p-1)^2}$$

is undefined.) Hence, the above expression can be replaced with

$$\frac{1}{(p-1)^2} = (p-1)^2$$

which indeed is a perfect square. So

$$\sum_{n=1}^{\infty} \frac{1}{p^{n+1}} = (p-1)^2 \text{ for } p = 2, 3, 4, \dots$$



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Taking a different tack Leonard Nissim responded with:

This problem can be solved by considering the Taylor Series at the origin for the function

$$f(x) = \frac{1}{(1-x)^2} = (1-x)^{-2}.$$

Via mathematical induction, one can prove that

$$f^{(n)}(x) = (n+1)!(1-x)^{-(n+2)}. \quad (1)$$

Indeed, the function as its own zero-th derivative begins the induction: $f^{(0)}(x) = (0+1)!(1-x)^{-(0+2)}$. The induction hypothesis, $n = k$, is $f^{(k)}(x) = (k+1)!(1-x)^{-(k+2)}$. For $n = k+1$, note that

$$\begin{aligned} f^{(k+1)}(x) &= \frac{d}{dx} f^{(k)}(x) \\ &= \frac{d}{dx} ((k+1)!(1-x)^{-(k+2)}) \\ &= (k+1)!(-(k+2))(1-x)^{-(k+3)}(-1) \\ &= (k+2)!(1-x)^{-(k+3)} \end{aligned}$$

Having proved (1), one can now evaluate the Taylor Series coefficients:

$$a_n = \frac{f^{(n)}(0)}{n!} = \frac{(n+1)!}{n!} = n+1.$$

Having determined the coefficients, the Taylor series is:

$$\sum_{n=0}^{\infty} (n+1)x^n = 1 + 2x + 3x^2 + \dots$$

The Ratio Test proves that this converges for all x with $|x| < 1$. One can re-index, letting $j = n+1$. This produces:

$$\frac{1}{(1-x)^2} = \sum_{j=1}^{\infty} jx^{j-1} \text{ for } |x| < 1 \quad (2)$$

Now, for any real $p > 1$, so in particular for $p = 2, 3, 4, \dots$, one has

$0 < \frac{1}{p} < 1$,
so that (2) may be applied with
 $x = \frac{1}{p}$:

$$\sum_{n=1}^{\infty} \frac{n}{p^{n+1}} = \frac{1}{p^2} \sum_{n=1}^{\infty} n \left(\frac{1}{p}\right)^{n-1}$$

$$= \frac{1}{p^2} \frac{1}{\left(1 - \frac{1}{p}\right)^2}$$

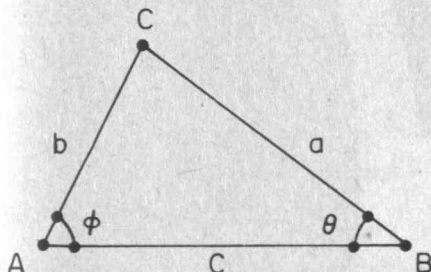
$$= \frac{1}{(p-1)^2}$$

Taking the reciprocals, one concludes:

$$\frac{1}{\sum_{n=1}^{\infty} \frac{n}{p^{n+1}}} = (p-1)^2.$$

Also solved by Robert Bart, John Chandler, N.F. Tsang, Roger Whitman, Gordon Rice, John Fogarty, Eli Passow, Stephen Persek, Henry Lieberman, Harry Zaremba, Jon Murnick, Alan Taylor, Alan Prince, Richard Hess, Matthew Fountain, and the proposer.

APR 4. Gordon Rice would like you to find non-equilateral triangles containing a 60-degree angle, all of whose sides are integers. How about 30 degrees? The following solution is from Harry Zaremba:



In the triangle shown,

$$\sin \theta = \frac{b}{a} \sin \phi,$$

and, $c = b \cos \phi + a \cos \theta$. Employing the identity $\cos \theta = (1 - \sin^2 \theta)^{1/2}$ and substituting for $\sin \theta$, the length of side c becomes,
 $c = b \cos \phi + (a^2 - b^2 \sin^2 \phi)^{1/2}$
For $\phi = 30^\circ$,

$$c = \frac{1}{2} (\sqrt{3}b + \sqrt{4a^2 - b^2})$$

and for $\phi = 60^\circ$,

$$c = \frac{1}{2} (b + \sqrt{4a^2 - 3b^2})$$

It is apparent when ϕ equals 30° that c will always be an irrational number since the term $\sqrt{3}b$ is irrational for any integer value of b . Hence, triangles with integral values for each side do not exist when one of the interior vertex angles is 30° .

When ϕ equals 60° , the number of triangles with each of their sides equal to an integer is limitless. Several solutions for integer values of c , a , and b are listed below.

a	b	c
7	3	8
19	5	21
13	7	15
31	11	35

Also solved by George Parks, Winslow Hartford, Steven Feldman, Robert Slater, Robert Bart, John Chandler, N. F. Tsang, Leonard Nissim, Stephen Persek, Richard Hess, Matthew Fountain, and the proposer.

Better Late Than Never

1987 A/5. Nob. Yoshigahara found a smaller solution.

1988 N/D 2. Gordon Rice believes the truth-teller could say "I know" and that the liar could say "I don't know."

N/D 3. Winslow Hartford believes "the old-fashioned day-coach paper drinking cup" when filled with water forms the shape needed. He adds, however, that "nobody knows what a day-coach is any more."

1989 JAN 2. George Parks has responded.

Proposers' Solutions To Speed Problems

SD 1. An inconceivable concussion.

SD 2. No pair and two pair.

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CAREER: After a World War II assignment in MIT's Servomechanisms Laboratory and a brief period in missile and rocket development, Mr. Marcy, EE'40, joined IBM in 1951, just in time for their serious push in computer electronics. He helped manage IBM's conversion from tube to transistor technology and its extensive expansion of technical resources. In 1974, he joined the government as assistant secretary of the Navy in charge of research and development and then served as vice president for computer technology at R.R. Donnelley, the nation's largest commercial printer. Cynthia and Tyler Marcy have five children and six grandchildren. They look forward to their 50th wedding anniversary in 1991 when, following his father and grandfather, Mr. Marcy will be the third generation of his family to celebrate that milestone.

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$$\text{forced case: } y'' + y + \varepsilon y^3 = \varepsilon \delta \cos(t)$$

$$y \sim \frac{36}{3} \delta \cos(t) + \frac{\varepsilon \delta}{72} (-\cos(t) + 3\cos(3t)) + \dots$$

$$\text{control pitch thru } \vec{u}: \vec{y}' = A\vec{y} + B\vec{u}$$

$$TFM_{1,1} = \frac{\alpha}{s^3 - 2s^2 + s - 2\alpha}$$

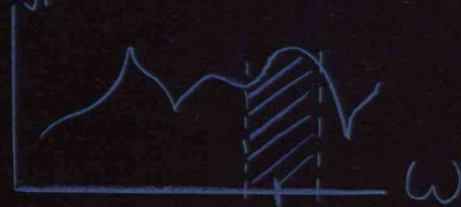
$$\left[\text{Matrix} \cdot t \right]_{1,2} = \frac{6e^{5/2}}{\sqrt{33}} \sinh\left(\frac{\sqrt{33}}{2}t\right) \text{ from Macsyma}$$

$$-pr((V^2)^2 + \sin^2(\Theta)(V^3)^2) + \frac{\partial p}{\partial r}$$

$$+ pV' \left(\frac{2V'}{r} + V^2 \cot(\Theta) \right)$$

$$+ V' \left(V' \frac{\partial p}{\partial r} + V^2 \frac{\partial p}{\partial \Theta} + V^3 \frac{\partial p}{\partial \varphi} \right) + \text{VISCOUS TERMS}$$

$$|TFM_{ij}|$$



$$\text{Fourier}|\sin(t)| \rightarrow \frac{2}{\pi} \left(1 - \sum_{n=1}^{\infty} \frac{(1+(-1)^n) \cos(nt)}{n^2-1} \right)$$

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Rags to Riches?

One Industry's Strategy
for Improving Productivity

AMONG recent U.S. initiatives to improve productivity and performance in a single in-

dustry, the Textile/Clothing Technology Corp., known as (TC)², is something of an anomaly. Where most cooperative programs involve high-tech industries—R&D consortia like the semiconductor industry's

*With government help,
U.S. apparel manufacturers and unions
are working together to modernize
their low-tech industry.*

low-tech apparel industry. And whereas in most industries, cooperation takes place exclusively among corporations, apparel-industry unions are full partners in (TC)².

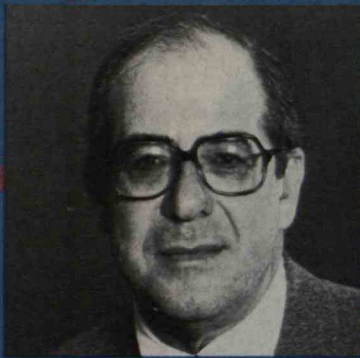
With an annual budget of

Sematech or the computer industry's MCC come to mind — (TC)² addresses the problems of the relatively

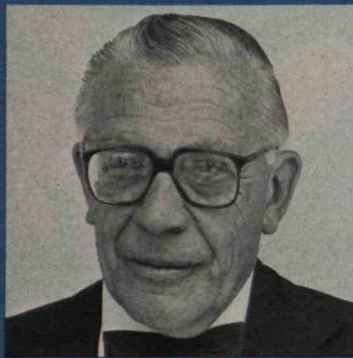
BY RICHARD KAZIS



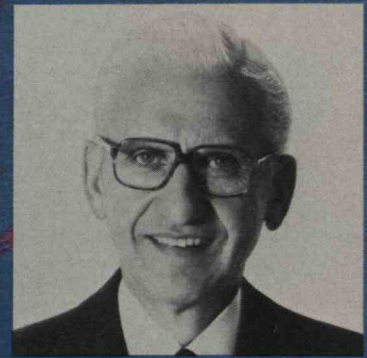
The Players



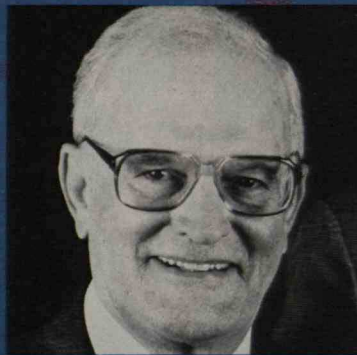
Murray H. Finley
Amalgamated Clothing and
Textile Workers Union



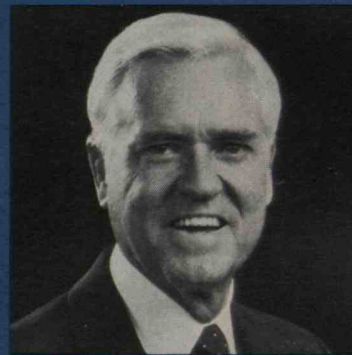
John Dunlop
Harvard University



Jerome Gore
Hartmarx Corp.



Bill Klopman
Burlington Industries



Sen. Ernest Hollings
(D-S.C.)

Academics, labor leaders, corporate executives, and politicians helped create the Textile/Clothing Technology Corp., or (TC)². Harvard industrial-relations expert John Dunlop proposed the cooperative

R&D program in 1977. ACTWU president Murray H. Finley was an early supporter. Jerome Gore, CEO of the largest U.S. men's suitmaker, Hartmarx, became the group's first president in 1980. His successor was

Bill Klopman, CEO of Burlington Industries, the largest U.S. textile manufacturer. In 1984, Klopman and Finley convinced Sen. Ernest Hollings to sponsor a federal grant to (TC)² of \$3.5 million per year.

about \$7 million—half provided by participating companies and unions and the rest by the federal government—(TC)² is perhaps the most comprehensive cooperative program for modernizing a traditional manufacturing industry. (TC)² has changed its direction several times in its nine-year history, and both its successes and its failures hold lessons for other segments of U.S. manufacturing.

RICHARD KAZIS is coauthor of Fear at Work: Job Blackmail, Labor and the Environment (The Pilgrim Press, 1982) and a graduate student in political science at MIT. During the last two years, he served on the staff of MIT's Commission on Industrial Productivity, where he did much of the research for this article.

The U.S. apparel and textile industries have traditionally produced relatively standardized goods in long production runs. Firms have looked to low wages for competitive advantage instead of developing new products and processes. But as world trade in textiles and apparel has grown, this strategy has left U.S. firms vulnerable to competition from even lower-wage producers in the Third World. (TC)² is one part of the industry's attempt to fight back—an effort to raise productivity by giving domestic firms access to improvements in technology and organization that they would never have initiated on their own.

*Many of the more than 15,000 U.S.
apparel manufacturers employ fewer than 50 workers and
operate with \$2,500 sewing machines.*

It has been a learning experience. At first, (TC)²'s research agenda emphasized expensive "break-through" technologies that might revolutionize the sewing process. The result was complex machines relevant only to the largest and highest-volume U.S. producers. So far only one commercial product has reached the market as a result of (TC)² research—a device for picking and placing fabric. And the market for this picker is still too small for it to be a money-maker.

Because of slow progress and the limited market for its complex automated systems, (TC)² has recently tried to change its focus to become more useful to smaller firms that want to improve quality, flexibility, and efficiency. The vast majority of apparel firms don't need revolutionary technology so much as assistance in making use of existing technologies. They need technology transfer more than technology development.

At the same time, (TC)² participants have learned that technology alone is not enough. Equally important is breaking down barriers to communication and cooperation among people and institutions that have had a long history of arm's-length relationships. The very existence of (TC)²—coupled with other mechanisms of cooperation such as lobbying, joint marketing, and coordination between suppliers and retailers—has helped improve relations within the apparel industry and between apparel firms and textile and fiber producers. These new networks are proving critically important in helping the industry move toward more efficient, flexible, and competitive operations.

The Price of Fragmentation

The companies and unions participating in (TC)² are part of the broad fiber-textile-clothing sector—industries that produce natural and synthetic fibers, turn them into fabric, and then use both fiber and fabric to make woven and knit garments.

The three industries are strikingly different. Synthetic-fiber producers such as Celanese and Du Pont are huge, capital-intensive multinationals more at home in the world of petrochemicals than that of small garment shops. The industry is highly concentrated in a few such firms, which have some of the most extensive R&D operations in the economy.

Textile producers, by contrast, include industrial

giants such as Milliken and Burlington, but also many small family-run businesses. There are between 6,000 and 7,000 textile companies in the United States, most located in the Southeast. Few do any R&D.

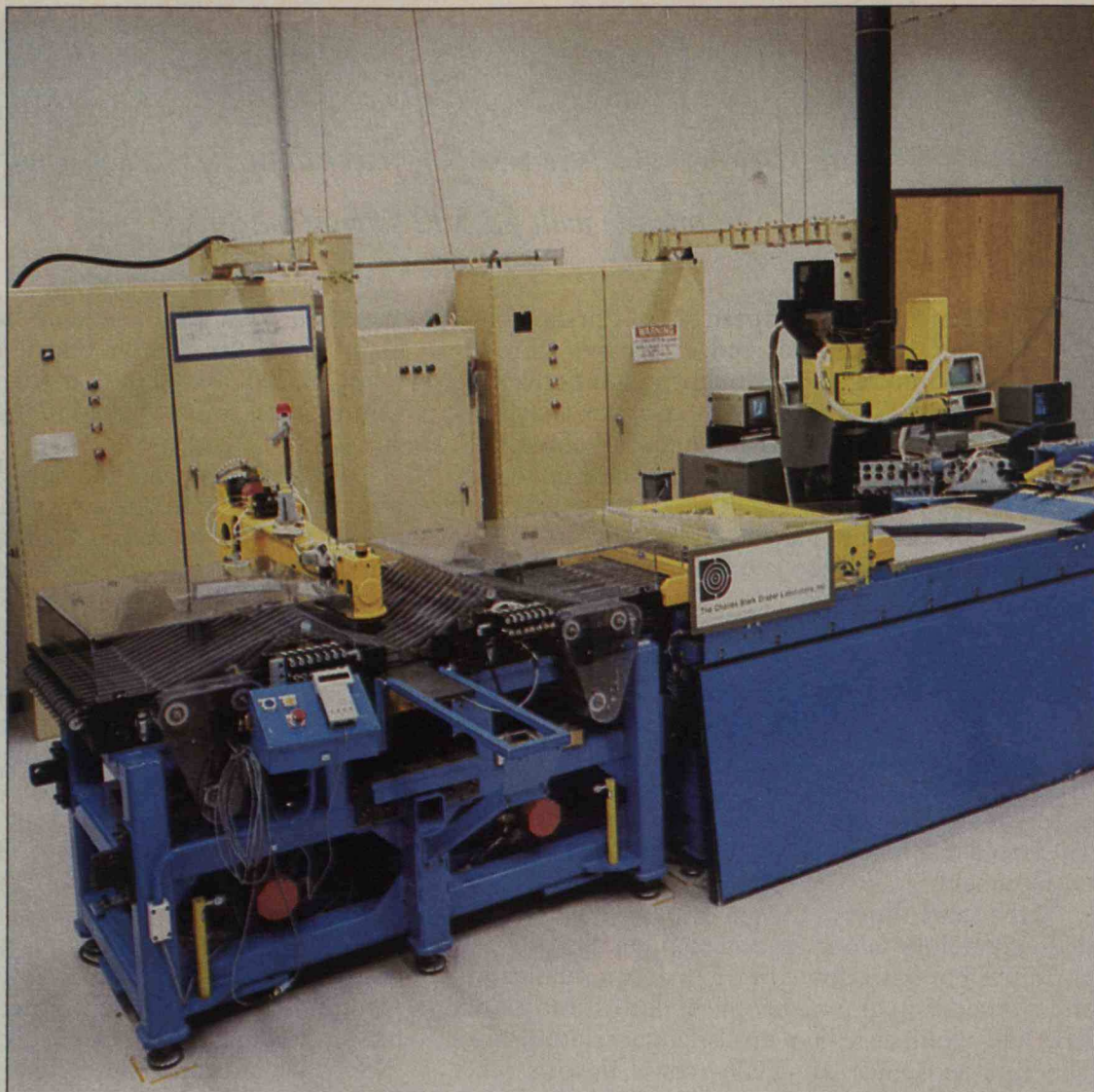
Finally, the apparel industry is one of the most fragmented manufacturing industries in the economy. There are over 15,000 U.S. producers. Some employ several thousand workers and produce in tremendous volume, while thousands employ fewer than 50 and operate with equipment no more sophisticated than a bank of \$2,500 sewing machines. In general, men's clothing manufacturers tend to be larger and more sophisticated than their counterparts in women's and children's wear.

Cultural and regional differences also divide these industries. For instance, there is a long tradition of distrust between the owners of non-union Southern textile mills and those of apparel shops, many of them unionized, in New York and other Northern cities. As a result, the various segments of the fiber-textile-apparel complex have coexisted uneasily, tending until recently to cooperate only as needed to secure markets and materials.

Such isolation has been costly. The lack of communication within the sector has made it extremely difficult for firms to adjust to rapidly changing markets. For example, all but the largest textile mills have always relied on independent sales agents to find customers, take orders, and pass along complaints. Direct contact with customers has been limited. The president of one textile mill told a member of MIT's Commission on Industrial Productivity how this arrangement cost him business. By chance, the mill owner happened to meet the manager of one of his largest customers, a leading men's apparel firm. After a brief conversation, it became clear that the garment firm had been ready for years to pay a higher price if the textile mill would customize a certain product, a request the mill was more than happy to oblige. But the information had never been passed along by the sales agent, largely because he believed that low prices, not special services, would maximize sales. Lack of communication had resulted in a missed business opportunity.

Of course, there is nothing like adversity to bring people—and firms—together, and in recent years both the textile and the apparel industries have experienced their share. In the 1970s and early 1980s,

The first prototype to come out of (TC)² was a machine to sew men's coat sleeves. Developed at Draper Labs, it was a technical success but was unsuited to commercialization. With its one-inch steel base and tables, complex custom electronics, and sophisticated fiber-optics vision system, the machine was too heavy, too fancy, and far too expensive. One (TC)² participant called it "the big blue monster."



sluggish demand and rising energy and materials costs combined to depress textile and apparel output, profits, and employment. Over 620 textile producers—about 1 in 11—went out of business between 1972 and 1983. Employment dropped from a high of almost a million in 1973 to its current level of under 700,000.

The apparel industry and the men's tailored-clothing sector in particular have been hit hard by imports. Fewer than 4 percent of clothes purchased in the United States in 1956 were imported. Today, imports account for over half of all garment sales. Roughly 2,000 apparel firms closed their doors between 1972 and 1983, putting over a quarter of a million people out of work.

In response, companies and unions in the fiber, textile, and apparel industries have embraced two strategies. One has been to appeal to the federal government for protection, an approach that dates

back to the 1960s but that has become more organized and vigorous since the 1970s. The second has been to lessen the large wage differences between the United States and developing nations by using automation to cut labor costs, and new forms of work organization to increase efficiency.

In fact, for many company and union leaders, the two strategies are intimately related. Without highly visible efforts to modernize, they feel, the industry can neither survive international competition nor win the political battle for tighter import restrictions. "We have to come to Congress with clean hands," says Art Gundersheim, vice-president of the 270,000-member Amalgamated Clothing and Textile Workers Union (ACTWU). "If we are pushing for import restraints, we have to be able to show that we are not protecting a backward, inefficient industry." (TC)² was conceived with this fact of political life in mind.

*The impetus for the clothing
industry's R&D program came not from manufacturers
but from the union.*

Labor-Management Innovation

The impetus for (TC)² did not come from the apparel makers or from apparel-machinery manufacturers. As has often been the case in the fragmented clothing industry, the call for cooperation came from the union—ACTWU and its president, Murray H. Finley.

Union leadership in the apparel industry goes back to the early years of this century. In those days, the industry was its own worst enemy. Firms continually undercut each other in a destructive wage competition that not only mobilized angry workers but also made it impossible for larger, more established companies to plan ahead. So after a citywide strike by Chicago clothing workers in 1910, the leading men's suit maker—Hart, Shaffner and Marx—recognized the union. The theory was that labor representation would improve worker morale and productivity and help stabilize the industry by removing wages as a factor of competition among firms. As other apparel companies did likewise and union membership grew, strikes and labor turnover began to moderate. The union helped firms introduce new technology, as well as new production methods and standards—all of which made the industry more stable.

The event that precipitated a new round of innovation from the union in the mid-1970s was a breakdown in collective bargaining between ACTWU and employers in the men's shirt industry, which had been especially hard hit by foreign competition. Employers demanded the right to import the low end of their product line. The union, fearing that jobs would be lost, refused.

A strike was averted only when labor and management agreed to a third-party study of the prospects for the U.S. men's clothing industry, which would serve as the basis for future negotiations. To conduct the study, negotiators chose someone who was trusted by both sides and was a friend of Finley—Harvard economist John Dunlop.

Almost an institution at Harvard, Dunlop began his career there in 1938. He has become perhaps the nation's most influential industrial-relations expert and an active proponent of resolving industrial disputes through a negotiation process much broader than traditional collective bargaining. During much of the postwar period, Dunlop headed commissions aimed at defusing conflict in areas as diverse as nu-

clear-power-plant construction, rail transport, the public sector, and retail food. In the 1970s, he served as Gerald Ford's secretary of labor and as a member of the president's Economic Policy Group. With his academic, union, industry, and political connections, Dunlop would prove central to the creation of (TC)².

Dunlop's study, published in 1977, argued that imports would almost certainly increase and that new strategies were needed if the industry was to retain its share of the domestic market. Among other proposals, he recommended that the industry create a cooperative R&D program. To lay the groundwork for the proposed venture, Dunlop turned to a Harvard colleague, engineering professor Fred Abernathy. Abernathy, who had been director of the engineering division at the National Science Foundation (NSF) in the early 1970s, helped secure a small NSF grant to study the idea of creating an R&D institution for the tailored-clothing industry. The NSF-funded study was part fact-finding, part consensus-building, and part salesmanship. Abernathy and Dunlop visited leading firms in the industry to examine their production processes, to gauge interest in an R&D program—and to encourage participation.

In August 1979, the Harvard professors convened a two-day conference of industry, union, government, and university representatives to report their findings and plan the next steps. Dunlop concluded that no single manufacturer would undertake the R&D initiative, but that a number of firms were interested in a joint effort. He proposed a nonprofit organization directed by representatives of the union, apparel firms, and equipment manufacturers, with support from academics.

Even though successful automation would mean fewer jobs, Murray Finley and ACTWU were enthusiastic. For one thing, the union believed that failure to boost productivity would cost jobs as surely as automation would. Moreover, Finley, approaching retirement, wanted to be remembered for raising the living-standards of union members. "It's no great thing to make \$11,000 in this country, as many of our members do," he told me. "While automation will eliminate jobs, the jobs that will remain will be more productive and will pay better."

Apparel-industry companies, however, were more hesitant. Large firms with their own research staffs feared they would give up more than they would

How the Japanese Are Doing It

WHILE the U.S. apparel industry has been involved in (TC)², the Japanese have also been trying to automate the sewing process. The differences in approach are instructive.

Established by Japan's Ministry of International Trade and Industry (MITI) in 1983, the project is funded solely by the government, with a nine-year budget of about \$60 million. The annual budget is roughly the same as that of (TC)², but the predictability of funding is something the U.S. program lacked in its first four years.

Unlike (TC)², which set out to automate particular sewing operations, Japan's Technology Research Association of Automated Sewing Systems (TRAASS) has a more ambitious goal: to develop a fully integrated manufacturing process. Research is progressing in areas other than sewing, such as automatic fabric inspection, cutting, materials handling, pressing, and production controls.

Japanese researchers are trying to break

away from the traditional concept of flat sewing, in which cloth is placed on a flat plane and run through a sewing machine. They are experimenting with three-dimensional sewing, which uses machines with moving heads that rotate in any direction and work on garments draped around dummies. Three-dimensional sewing could prove far more flexible than flat sewing and more suited to short runs of customized products. If successful, this approach could give Japanese technology a versatility that (TC)² machines cannot match.

Finally, the membership of TRAASS and (TC)² differ significantly. In Japan, unions are not involved. And while large textile and apparel firms set the course for (TC)², world-class equipment manufacturers are among the key Japanese players. This makes rapid commercialization more likely. It also means that any technical improvements will quickly spread to the equipment manufacturers' other product lines.

—Richard Kazis

gain. Equipment manufacturers, as well as apparel firms outside the tailored-clothing segment, showed little interest: many were afraid the union would call the shots, others did not see enough direct benefit, and many thought the \$50,000 annual membership dues were too high. Textile firms, most of which were intensely antiunion, also stayed on the sidelines.

Finally, in October 1980, ACTWU and four companies created what was then known as the Tailored Clothing Technology Corp., or (TC)². The corporate participants were three men's suit manufacturers—Hartmarx (formerly Hart, Shaffner and Marx), Palm Beach, and Greif—and the menswear division of the largest U.S. textile manufacturer, Burlington Industries, which supplied worsted goods to the three suit-makers. Hartmarx CEO Jerome Gore became (TC)²'s first president.

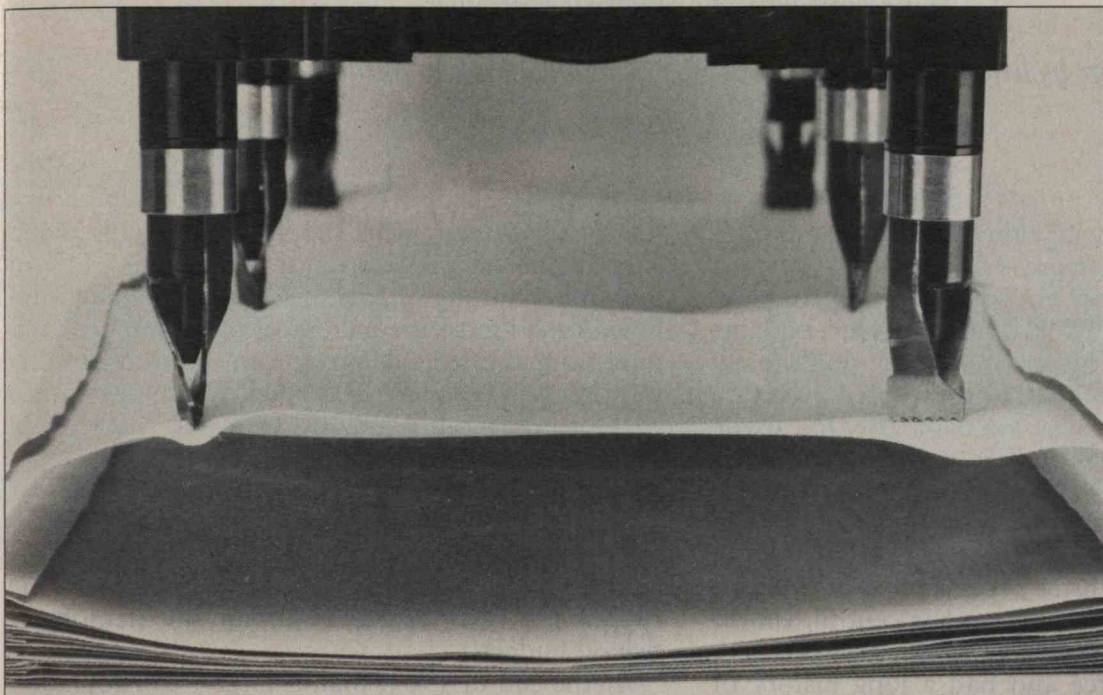
For these firms, the decision to join reflected an investment in labor-management cooperation as much as a commitment to technological modernization. "Here was the union asking top management for support," remembers Fred Shippee of the Amer-

ican Apparel Manufacturers Association, an early critic of the program. "They joined because the union was asking them." Modest first-year funding of \$450,000 came from membership dues and from a \$200,000 U.S. Commerce Department grant, arranged with help from John Dunlop.

Moving Limp Fabric

Abernathy's analysis had revealed that sewing accounted for only 25 percent of labor time in men's suit production while the remaining 75 percent was spent moving materials. For automation to improve productivity significantly, it would have to focus not just on the sewing machine but on the entire sewing process.

The obstacles to automation were many. It is one thing to devise a robot that can move nuts and bolts or mount chips on printed circuit boards. But how can machines position limp fabric for accurate sewing? A robot would have to be able to pick up one piece of cloth at a time, constantly adjusting to



A device for picking and placing single pieces of fabric is the first commercial product to reach the market as a result of (TC)² research.

changes caused by temperature and humidity, and to wide variations in size, pattern, style, and material. A men's suit manufacturer might have as many as 65 slightly different versions of its basic sleeve. And the robot would have to be able to adapt to a complicated sequence of sewing operations, since assembling a man's suit can take 150 different steps. Moreover, skilled operators constantly adjust their activities to compensate for errors made at previous steps. An automated sewing system would have to be flexible enough to perform the subtle adjustments necessary to make a suit "look right."

In the 1960s, the consulting firm Arthur D. Little had received federal funding to develop an automated sewing system. The firm managed to build robots that could pick up, position, and transport generic rectangles of cloth. Unfortunately, apparel pieces are irregular in shape, and the machines never made it out of the lab. When federal funding ran out, the project died.

By the late 1970s, major innovations in microelectronics had made the task of automated sewing technically feasible. New computer-vision systems could help solve positioning problems. The mathematical description of cloth parts that made it possible to computerize marker-making could also direct robotic arms and sewing heads.

The problem was that traditional suppliers of sewing machinery had little incentive to capitalize on these new technologies. For one thing, they lacked expertise in microelectronics and robotics. For another, no equipment supplier was so dependent on

the apparel industry that it felt compelled to develop new sewing technology. Seat belts, sheets and towels, and cement and kitty-litter bags account for more miles of thread in a year—and more industrial sewing-machine sales—than do all the clothes produced in this country.

The lack of interest among equipment manufacturers led (TC)² to look elsewhere for technical know-how. The corporation decided to contract for product development with Draper Labs of Cambridge, Mass., best known for its military and space-related R&D on inertial guidance systems. While Draper had no apparel-industry expertise and little experience working with cost-sensitive industries, it was well versed in electromechanical engineering and vision systems. "(TC)² figured it was easier to teach sewing to high-tech people than the other way around," says Dick Aroujo, Draper's current (TC)² program manager.

(TC)² asked Draper to develop in two years a prototype system that would fully automate one of the most difficult and labor-intensive tasks in the unionized tailored-clothing industry—the sewing of men's coat sleeves. The system design was to be modular so it could be adapted to other garments that, like men's sleeves, involved a lot of long-curve seams. Draper's prototypes had to work but were not expected to be ready for immediate use by industry.

Upping the Ante

Even as Draper got to work, the structure of (TC)²

*The consortium's original emphasis
on technological breakthroughs did not meet the immediate
needs of most apparel firms.*

was changing. Convincing other firms in the tailored-clothing industry to join proved difficult. At the same time, large textile and fiber firms began to show greater interest. ACTWU's Murray Finley explains the shift this way: "The apparel people don't really care whether they produce in the United States or not, since they can always go offshore. But the textile companies need a healthy U.S. apparel industry to buy their products. They can't sell cloth to the Koreans, because the Koreans can get what they need for less in Asia."

As textile and fiber firms became more prominent, ACTWU's role in (TC)² became less central. Unlike the tailored-clothing industry, where ACTWU represented the workforce and had a long history of cooperation and leadership, the new members such as J.P. Stevens, Du Pont, and the Russell Corp. were predominantly non-union. Not that they wanted to antagonize the union or force it out. Like the tailored-clothing makers, they understood the importance of presenting a united front when lobbying on trade issues. (TC)²'s funds remained in an account at ACTWU's Amalgamated Bank. And the union retained an informal veto over new dues-paying members.

As more large manufacturers of fibers, textiles, and apparel joined (TC)², Burlington Industries chief executive officer Bill Klopman began to take a leadership role. Klopman, who had been with Burlington since 1946, was appointed CEO in 1976. He was one of the driving forces in the increasingly sophisticated textile industry, active in building his own firm and a leader in shaping the industry's political strategies.

At a 1983 (TC)² board meeting, Klopman took charge, effecting a kind of friendly takeover. He felt that preliminary results from the Draper research were promising but that significant progress would require a lot more money. "It was either up the ante or do nothing," recalls Klopman. By the time the members rose from the table, over \$5 million had been raised and the assembled CEOs had committed themselves to three years of support at that level. It was little more than a formality when Klopman was chosen to replace the retiring Jerome Gore as president in April 1984.

Klopman aggressively pursued more participants and funding from Burlington's competitors, customers, and suppliers—even to the point of enlisting

the sheep growers who supply Burlington's wool. Most important, industrialist Klopman, CEO of non-union Burlington, and union leader Finley combined forces to secure increased and continued support from the federal government. During its first four years, (TC)² had depended on annual appropriations of about \$400,000 from the Department of Commerce, funding that was challenged regularly by the Reagan administration. To secure its 1985 funding, Finley and Klopman convinced Senator Ernest Hollings (D-S.C.), who represents one of the largest textile states, to introduce federal matching support for (TC)² as a \$3.5 million line item in the federal budget.

By the end of 1984, thanks largely to Klopman's efforts, the Tailored Clothing Technology Corp. had a fairly stable budget of about \$7 million, 13 dues-paying members, and about 40 other contributing companies in fibers, textiles, sportswear, and tailored clothing. At a late-1984 board meeting, (TC)² formalized this dramatic transition from an organization consisting primarily of a few men's suit manufacturers to one representing firms throughout the entire fiber-textile-apparel complex by changing its name to the Textile/Clothing Technology Corp.

Technological Success, Commercial Failure

(TC)² was achieving some organizational and financial stability, but its R&D efforts faced serious obstacles. As contracted, Draper's engineering team developed a working prototype of the sleeve machine by September 1983. But the machine was nowhere near commercial viability. It took six minutes to make a sleeve that an experienced manual operator could sew in two.

More accustomed to the demands of the military than the rag trade, Draper had produced a machine that reflected the firm's engineering wizardry but also its distance from the realities of a highly competitive industry. The firm used one-inch steel for the base and tables. The prototype had banks of complex custom electronics behind it. The vision system used sophisticated fiber optics. The sleeve machine was too heavy, too fancy, and far too expensive. Bill Klopman derisively called it "the big blue monster."

Engineers from the Singer Co., the firm selected by (TC)² to turn the prototype into a commercial product, worked closely with the Draper team to



In 1986, (TC)² established the National Apparel Technology Center, in Raleigh, N.C. The center is a technical-support organization helping apparel firms of all sizes improve productivity through changes in the way they manufacture.

build a simpler, faster, and cheaper version. Yet the sleeve machine as designed still had no commercial potential. In an effort to develop more marketable products, the Singer staff adapted the Draper prototype—now called the “woven fabric machine”—for other long-curve seam applications: a system for sewing suit backs and another for trouser inseams, side seams, and waistband seams.

While these new machines represented a technical step forward, they still had little chance of commercial success. They were too expensive—between \$100,000 and \$400,000—and so productive that only the largest firms would have any use for them. The suit-back machine could sew 240 pieces an hour. There weren’t enough high-volume suit manufacturers to constitute a viable market.

The prototypes coming out of Draper and Singer reflected an even more serious problem. (TC)²’s research agenda emphasized long-range technological breakthroughs for the tailored-clothing industry. But this satisfied neither the high-volume textile and apparel producers, such as Russell or J.P. Stevens, who had recently become members, nor the vast majority of other firms in the apparel industry, who saw long-term R&D as irrelevant to their more immediate needs.

To respond to the first group, (TC)² turned to developing technologies more applicable to high-volume production outside the tailored-clothing sector. Draper began to develop a “knit fabric machine” to automate the sewing of sweatpants and other knitwear, garments that pose a host of new technical problems because of the stretchy fabric. This time, Draper and Singer used their experience with the

first machine as a guide to stripping out cost and complexity. Engineers used off-the-shelf components whenever possible. And from the outset, they worked closely with staff at Russell and other potential users of the new machine, learning about their needs and constraints from close observation. The prototype—recently installed at Russell’s Alabama production facility—is significantly closer to commercialization than was the original sleeve machine.

Still, the knitwear machine will be economically practical for only a few large manufacturers. Draper engineers say that for the machine to be profitable, it will have to produce a million pairs of sweatpants a year. Only a few firms have such volume.

Emphasizing Technology Transfer

For the vast majority of firms in the apparel industry, neither the woven nor the knit fabric machine made a great impression. (TC)²’s research was far removed from their primary concern—economic survival. Fewer than 12 percent of firms in the apparel industry use even relatively simple and cheap technologies such as programmable needle positioning and undertrimming—technologies that can increase both quality and productivity. For these firms, the greatest need is for assistance in choosing among all the hardware and software already on the market.

Realizing that the organization needed to show more immediate results if it were to engage small and midsize apparel firms, (TC)² began to look for ways to refocus its program. A new emphasis is on finding elements of the original machines that might be broken out for immediate use. One such inno-

The National Apparel Technology Center emphasizes technology transfer. Three days a week, the center runs a demonstration factory staffed by about 30 operators. They produce high-quality men's dress slacks on \$3 million worth of state-of-the-art equipment. The factory is not restricted to (TC)² members. The remaining two days of the week, (TC)² members experiment with changes in equipment, software, and factory-floor organization.



vation is a system that can detect skipped stitches, a product of Draper's vision research that could have a large market. "The philosophy has changed," says Dick Aroujo. "People may once have thought there would be a wonder machine that would solve all the industry's problems, but they no longer think so. If there is something small we can get out to the factories, we'll try it."

(TC)² took an even more important step in 1986: it established a National Apparel Technology Center, located in Raleigh, N.C., next to North Carolina State University. The center is trying to become what the apparel industry has always lacked—a technical-support organization helping firms of all sizes improve competitiveness through changes in the way they manufacture.

Three days a week, the center runs a model factory staffed by about 30 operators and producing high-quality men's dress slacks on \$3 million worth of state-of-the-art but commercially available equipment. The factory, open to (TC)² members and non-

members alike, demonstrates traditional shopfloor organization as well as new production systems designed to cut materials-handling and inventory costs. Operators are trained to perform several tasks each. Computer systems are used for product design, planning, management control, engineering, data collection, and other functions.

The remaining two days a week, (TC)² members use the center's technology to experiment with changes in equipment, software systems, and factory-floor organization. In conjunction with N.C. State researchers, the staff is developing computer-simulation models for evaluating changes in scheduling, costs, in-process inventory, labor requirements, and other elements of production. This service is a boon for companies on tight budgets. "We're too small to afford our own research and development," says L.E. Gibens of Lucky Star Industries in Baldwyn, Miss., a recent (TC)² member. "So we find it very useful to evaluate a working project in action without having to make an invest-

"People may once have thought that a wonder machine would solve all their problems," says one consortium participant, "but they no longer think so."

ment in equipment and personnel."

The center also runs short seminars and training programs for apparel industry employees, from mechanics to top management, on topics such as computer fundamentals, job-methods engineering, and "stitchology"—the mechanics of sewing stitches.

"Management can go down there and discuss ideas and technologies with people who aren't trying to sell them anything but improved productivity," says Harvard's Fred Abernathy. "They can ask the kinds of questions they thought were too stupid to ask suppliers."

This new direction has attracted the participation of apparel firms that had previously discounted (TC)². The American Apparel Manufacturers Association, which had kept its distance, recently established a formal relationship with (TC)² and is actively promoting the program to its members. Today, 43 firms belong to (TC)². Most of the new members come from the apparel industry.

The center's technology-transfer philosophy has also begun to attract the women's segment of the apparel industry, where long-curve seam applications are more limited. Just this year, the International Ladies Garment Workers Union (ILGWU), 95 percent of whose 170,000 members work in women's and children's wear, finally joined (TC)². "A lot of women's clothing firms have primitive technology," explains James Parrott, executive assistant to ILGWU president Jay Mazur. "They are using outmoded equipment and, as a result, have trouble competing with more innovative firms. With (TC)²'s shift in focus, we see an opportunity to work with the organization to develop programs that would help our members' employers make use of equipment that is on the market now."

A Package of Strategies

As (TC)²'s R&D strategy has shifted, the way the fiber-textile-apparel complex sees the role of technology in industrial recovery has also evolved. In the past decade, these industries have learned that no single strategy can ensure economic health and innovation. (TC)² is only one of several related cooperative efforts reshaping working relationships in the industry.

Joint labor-management lobbying on trade legislation and policy continues under the leadership of

Bill Klopman, now the executive director of (TC)², and others. A second initiative is the Crafted with Pride in America Council, a "Buy American" marketing campaign spearheaded and funded largely by textile manufacturer Roger Milliken.

Probably the most significant of these cooperative efforts is Quick Response, an ambitious attempt at improving the links among fiber, textile, and apparel firms and the retailers that sell their products to the public. The goal is to cut the time it takes to turn retail orders into deliverable goods from the current average of 66 weeks to as few as 21 weeks. If it works, Quick Response should reduce warehouse time, cut in-process inventory, improve communication flow from retailers to manufacturers and suppliers, and make domestic apparel sources more appealing to retailers than comparable imports. Quick Response is another attempt to overcome the high costs of fragmentation in the apparel industry. According to Du Pont vice-president Pete Butenhoff, a key player in both (TC)² and Quick Response, the strategy is "to have the retailers pull the apparel manufacturers into the twenty-first century."

Initiatives like (TC)², Crafted with Pride, and Quick Response will not have a major effect on the apparel and textile industry's import, profit, or employment levels in the near term. Nevertheless, the importance of such efforts should not be minimized. They have already done much to make the industry more cohesive. Textile companies and unions, once sworn enemies, now have regular forums for cooperation. Multinational fiber producers, Southern textile mills, and apparel shops around the country have an institutional framework for overcoming long-standing economic and cultural barriers.

While these efforts in no way guarantee success, it is difficult to imagine a healthy apparel industry—and, by extension, healthy textile and fiber industries—without them. The technological innovations of (TC)² and the organizational links of Quick Response are part of a loosely coordinated package of strategies that are breaking down barriers in these traditionally adversarial industries. As a participant at an early planning meeting for Quick Response told me: "It was incredible having textile, apparel, and retail firms sitting down at the same table to think through their problems. An emotional response developed as people began to realize: 'This is something we can all benefit from.' " ■





Rethinking the Military's Role in the Economy

An Interview with Harvey Brooks
and Lewis Branscomb

EVER since World War II first prompted civilian scientists to work under government contract to aid the war effort, military funding has played a significant role in the American economy. Research sponsored by the Defense Department is widely credited with prompting key advances in computing in the 1950s, including time sharing, and with fostering the nascent jet aircraft in-

*Two Harvard technologists
explain why the Pentagon does not
nurture civilian industry the way
it once did.*

dustry—one of the few sectors the United States still dominates today. Military-supported R&D quickly became accepted as the American engine of industrial growth. A single investment was seen as producing a double payoff: technological leadership in both weapons and commerce.

Defense R&D reached its relative peak in 1960, when it constituted nearly half of all research

The C-5A was so complicated that Lockheed couldn't design and build a civilian counterpart at the same time.

funds spent in the United States, and 80 percent of all federally sponsored science. After a drop in the 1970s the numbers climbed along with the military buildup of the 1980s to stand today at 67 percent of federal R&D. Unlike past increases, however, the recent growth has earmarked ever more funds for the design and production of specific weapons. Basic research—the area most likely to be of value for civilian uses—has declined from 6 percent to 2 percent of defense R&D.

Perhaps that is why, as Americans grapple with fundamental questions about the health of the U.S. economy, they no longer take for granted the wisdom of using the military as a surrogate industrial-policy agency. The Defense Department's massive investment in the country's technology does not seem to automatically produce "spinoffs" that show up as consumer products. The Defense Department itself fears weaknesses in the civilian economy: a report by the Defense Science Board last fall proposed that DOD take an even more active role in determining the key industrial areas where government should ensure economic health.

Harvey Brooks, Lewis Branscomb, and several of their colleagues at Harvard's Kennedy School of Government have established the Dual-Use Technology Project to examine the complex relationship between military and commercial technology. Participants in the three-year effort, funded mainly by the Sloan Foundation and the Carnegie Corp., want to better understand how the United States can improve both its industrial competitiveness and its military security.

Both Brooks and Branscomb are physicists with experience in industry who made their way into the public-policy arena. Brooks is Benjamin Peirce Professor of Technology and Public Policy as well as Gordon McKay Professor of Applied Physics (both emeritus) at Harvard, where he has been on the faculty since leaving the GE Research Laboratory in Schenectady in 1950. Branscomb, chief scientist at IBM until 1986, is the Albert Pratt Public Service Professor at Harvard and directs the Kennedy School's Science, Technology and Public Policy Program.

Technology Review editors Sandra Hackman and Robert Howard recently asked Brooks and Branscomb about the results of their interviews with members of industry, government, and academia. Not only is defense spending a mixed blessing for the U.S. economy, they told *Technology Review*, but its role is changing.

TR: The conventional wisdom is that military R&D leads to technological spinoffs that benefit civilian industry. Have you found that the Defense Department plays a positive or a negative role in the U.S. economy?

BROOKS: The whole problem of spinoffs from defense is a mess because nobody asks the question, "Compared to what?" Suppose you posit that if the military didn't spend the money it now has for R&D, nobody else would either. Then clearly you get spinoff. But if you assume, as defense critics do, that the country would spend the same amount of money on civilian research that it now spends through DOD, clearly that would produce more civilian economic benefit. The problem is, neither of these extremes represents a realistic scenario.

You can't spend \$40 billion a year on R&D without some spinoff. But it's an accidental by-product. If producing civilian technology is your main objective, and you really don't care much about defense, you could get the same amount of spinoff with much lower expenditures.

BRANSCOMB: Most of the recent discussion about the declining competitiveness of U.S. industry assumes that spinoff is overrated, but nobody gives evidence to support that conclusion any more than they did 20 years ago when they said it was underrated. The truth is you've got to get way below the surface to discuss the question of diffusion of technology from defense, because in some industries it's very strong and effective, while in other industries it's probably negative.

The classic example of spinoff—designing a military product and then thinking of a civilian use for it—occurred in the 1960s when Boeing bid on the huge C-5A military transport and lost to Lockheed. Boeing said, "Since we've already spent large sums of money, why don't we try to use what we've learned to build a new commercial airplane?" So they salvaged a lot of the work and it showed up in the 747. The jump in oil prices came along just in time to make that an even better deal.

Meanwhile, you might have thought Lockheed would beat Boeing in the next generation of aircraft technology by capitalizing on its experience with the C-5A. But that aircraft was such a complicated technological problem that Lockheed lacked the capacity to design and build a 747-kind of airplane concurrently. When they finally started the

Lockheed 10-11, it was too late—the window of opportunity had closed. That story suggests that the conditions for spinoff are very tender and special and include many factors other than technology.

An even more important effect from military R&D isn't spinoff at all—it's the joint development of technology for both civilian and defense purposes, what we call "dual use." A good example of that occurs at Hughes Aircraft, where one team of engineers builds the structure, solar panels, and telecommunications for both military and commercial satellites. It's interesting that Hughes enjoys 70 or 80 percent of the world's commercial market, but they have only 30 percent of the military market.

BROOKS: Their commercial business is driving their military business. They appear to be most successful in bidding on military work that fits well with their civilian operations.

TR: Do defense contractors often develop technology that can be used in both sectors?

BROOKS: We've found that they rarely do. Most of the big companies, especially, keep their defense work almost completely separate. And these firms' military contracts are usually an even smaller part of their total business than at Hughes. General Electric does only 9 percent of its business with DOD, IBM 2.5 percent, and General Motors about 3 percent.

The big companies seem to prefer it that way, but DOD also apparently has a policy of spreading work around. No one firm does more than about \$7 billion worth of the Pentagon's \$150 billion weapons-buying business. And the major prime contractors subcontract about 50 percent of the work they do get. The subcontractors are the ones who are developing most of the dual-use technology. For example, the Lord Co., of which Lew is a director, makes all kinds of specialized shock mounts for both helicopters and outboard motors.

BRANSCOMB: The subcontractors are not well known because they build components and subsystems such as hydraulic valves rather than end-user products. These companies are not huge—they typically have annual revenues of about a couple hundred million dollars. And they're usually not diversified—they compete with a few other firms in the same niche.



Success Stories

TR: Are semiconductors an example of a technology where defense R&D did create a new civilian industry?

BROOKS: Not exactly. DOD spent a lot of R&D money on semiconductors, but most of the key fundamental advances came out of private R&D, including the transistor and integrated circuits.

TR: So the Defense Department didn't do a good job of predicting which designs would pan out?

BROOKS: Right. But even so, by spending money on R&D, DOD created a large pool of knowledgeable people—scientists, engineers, and technicians. And the private sector was willing to invest its own money because it was clear that the military would be an enormous potential market for a good semiconductor device. DOD also put a lot of pressure on everyone to share information.

BRANSCOMB: In computing, money from the Advanced Research Projects Agency (ARPA, now called DARPA) proved absolutely critical to pushing basic research in the

The whole question of spinoffs from defense is a mess because nobody asks, "Compared to what?"

Spinoffs from military R&D are less likely today because the window of opportunity for commercializing an idea is much narrower.

1950s. Universities were just beginning to have PhD programs in computer science. DARPA chose a few schools—including MIT, Carnegie-Mellon, Berkeley, and Stanford—and said, in effect, “We’re going to give you a million dollars a year forever to work on advanced uses for computers.”

The four schools did research on artificial intelligence, beginning with speech processing and then moving on to image processing and expert systems. The Air Force also sponsored research on language translation—trying to make a machine that would automatically translate Russian into English. It didn’t work, so you could say it was a big waste, but people learned a lot about language in the process, and some of that proved useful in developing higher-level computer software.

Many of these projects were individual experiments, and most were theoretical. But in the case of time sharing—which enabled a single mainframe to perform concurrent computations from separate remote terminals—DOD-funded scientists at MIT actually built an operating system. Nobody uses that system today, but it’s a good example of developing a successful prototype to prove a principle.

TR: Is DARPA’s current funding of research on parallel processing likely to prove just as important?

BRANSCOMB: Yes, because whenever you try to increase the speed of computers, the design becomes so complicated that you need a big revenue base to sustain the research effort—which IBM and some Japanese companies can do but few others can. DARPA also has a technology-diffusion strategy: it contracts with companies to build prototypes of what the universities come up with so industry can exploit new ideas more rapidly.

That’s very useful so long as the whole effort is very well informed. Conservatives and industry people always complain that the government can’t possibly figure out which technology to go with. But the government is full of smart technical people. If industry executives would divulge what they truly think the important technologies are, the government could do a lot better job. The executives should stop complaining and start cooperating.

BROOKS: I don’t entirely agree about the value of DARPA’s most recent efforts. I think

the agency is focusing more narrowly on elaborate and sophisticated military uses of both artificial intelligence and parallel processing, rather than on generic technologies that will prove useful to industry.

TR: Has such a policy led to mistakes in the past?

BROOKS: The evolution of U.S.-made programmable machine tools, clearly a dual-use technology, may have been distorted by military priorities. The Air Force pushed American manufacturers to develop the most sophisticated designs for machining military-aircraft shapes, expecting that the results would filter down for civilian uses. But the U.S. industry lost out to the Japanese, who began with more elementary applications with much broader commercial markets and gradually moved up the sophistication scale. It’s a trickle-down versus trickle-up theory.

The Japanese also standardized the controllers and associated software for the machine tools, so that everyone who bought one did not have to learn a new language—the problem we face today in the personal-computer market. The tools were both affordable and understandable by small firms.

TR: Does that experience indicate that the United States needs a civilian DARPA to sponsor research of direct commercial use?

BRANSCOMB: In a sense we had a civilian DARPA from 1950 to 1970—Bell Labs. I used to tease my friends who worked there because they knew they were very good. I’d say, “I acknowledge: Bell Labs is the best government laboratory in the country.” And when they got mad, I’d say, “Come on now, the more money you spend, the more money the telephone ratepayers have to give you.” Bell Labs was excellent in science and systems engineering, on which AT&T depended.

BROOKS: Not only did rate regulation allow the company to spend a portion of telephone revenues on research, but antitrust decisions forced AT&T to license technology of use outside the Bell system to all comers at reasonable fees. It was essentially a spinoff policy. The lab’s scientists were also under great pressure to publish: they used to charter entire airplanes to send abstracts to physical society meetings to beat out other people. And the staff was closely connected to the outside basic-research community.

TR: Could Bell Labs serve as a model today?

BRANSCOMB: The problem is finding money to fund a civilian agency and political consensus to set its agenda. Congress allows DOD to fund projects such as Sematech (the semiconductor research consortium) and high-definition television because defense is constitutionally sheltered—you can justify a lot of programs by saying they are necessary for national security. In the 1950s a major bill aimed at providing financial support for education, both college and K through 12, languished until Sputnik. The next day the bill's title was changed to the National Defense Education Act and it took off.

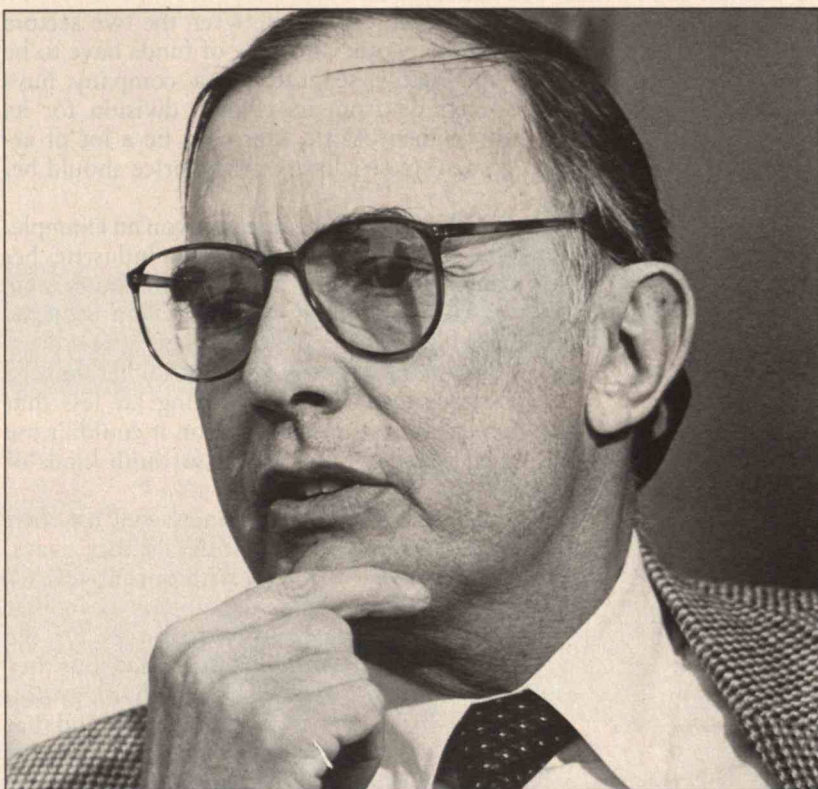
We also expect the military to be inefficient. If DARPA says it thinks a 64-way parallel processor that computes at 100 gigaflops is important for national defense, but the four little companies it funds all go bankrupt and the universities give up, everybody says "you win some, you lose some." But if a Commerce Department DARPA did that, the Business Roundtable would go in to the president and say, "These civil-service types pretending they're industrial executives are wasting a lot of innocent taxpayers' money."

Barriers to Dual Use

TR: Are spinoffs from military R&D less likely today?

BROOKS: Yes. The window of opportunity for commercializing an idea is much narrower. Back in the '50s and '60s, if you were slow and made mistakes, it didn't make much difference—nobody except American industry was capable of making and marketing the products. U.S. manufacturing productivity—GNP per worker—was two and a half times higher than in any other industrial country. Today dozens of countries are able to exploit new technology no matter where it originates, since it flows very freely. Where 30 or 40 years ago you probably had 10 years to experiment, now you have only 3 or 4 years to keep ahead of the competition.

BRANSCOMB: And civilian industry has often moved ahead of military needs, which makes it difficult to share technology. Take electronics. DOD has developed a whole series of specs so that if someone designs a circuit board, it will accommodate the pins on any military chip. But commercial firms have introduced many more advanced semi-



conductor package technologies. With the U.S. civilian electronics market seven times the defense market, DOD has terrible problems getting people to bid. That's why it spent a billion dollars on very high speed integrated circuits (VHSIC)—to attract semiconductor makers to serve military needs, and to induce the services to specify a high density of chip functions in their designs of electronic equipment. That would encourage companies to bid on components for military systems.

TR: Are you finding other barriers to dual use within civilian industries?

BRANSCOMB: The big companies isolate most of their defense work from their commercial technology because of DOD's special accounting rules, and because of the many factory inspectors trying to prevent fraud. The military's policy of insisting that things be lily-white makes it more difficult for contractors to pursue a dual-use strategy. The government's attitude is that a company that tries to maintain a shared technology base may wrongly allocate the costs of commercial development to the military.

BROOKS: There's so much concern in Con-

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Civilian industry often moves ahead of military needs, which makes it difficult to share technology.

gress about overlap between the two sectors that the people and flow of funds have to be kept rigidly separate. If a company buys something from its civilian division for its government work, there can be a lot of argument over what the right price should be.

BRANSCOMB: Let me give you an example. The government is suing Litton Industries because of how they allocated computer time between their military and civilian projects. Now it's entirely possible that Litton overcharged the military side. But I'll bet that the Defense Department is paying far less that way than if it had told Litton it couldn't use the same computer center for both kinds of work.

Another reason companies wall off their defense operations is that the Pentagon says, "If you invent a widget with our money, we can insist that you give the plans to another company so we have two sources for the item." Nobody would contest that. But they also say, "Any of your own technology you use in this widget also belongs to us, and that means we can give it to your competitors if we deem it to be in the national interest." So companies with a large base of proprietary technology may decline to bid on military projects for fear of losing their advantage in civilian markets.

Companies also separate their military work because they are afraid it will drag down their commercial operations. Most of the executives we have talked to say they wouldn't dare mix the managers of their defense business with their commercial operations because those people might forget what they know about cost control and fast market response. Similarly, if the companies put their commercial people in their defense business, they'd probably never get an order because those people wouldn't understand how defense markets operate. There you have to sell the product before you build it.

BROOKS: Another barrier to dual use of technology is the military's separation of R&D from procurement. The laws were changed in 1986 to make it less likely that a company will get the contract to manufacture something that it has developed. The motivation was to encourage greater competition among defense contractors, and hence lower prices, in producing weapons. However, that's also discouraged people from worrying about manufacturability when they design a defense item, which means it will often be

too expensive for the civilian market.

BRANSCOMB: And—as the MIT Productivity Commission's *Made in America* points out—integrating technology with manufacturing is where we're in the worst shape relative to the Japanese. You could argue that we've learned that bad habit from the country's weapons-buying system. Part of the problem is military contractors never know how large a production order is going to be—that depends on congressional appropriations. If a company could plan an order five or six years ahead, it would have more of an incentive to invest in manufacturing facilities to get costs as low as possible.

The Defense Department is moving in the direction of awarding longer-term contracts, but the budget cutbacks will provide a tremendous temptation to slice them.

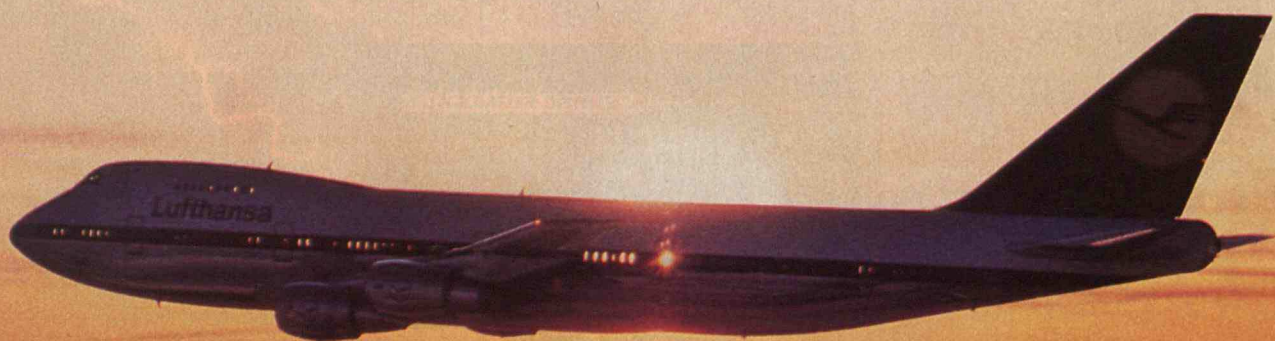
Creating a Better System

TR: Will cutbacks in the defense budget hurt the nation's R&D?

BRANSCOMB: Private industry has increased its own R&D efforts substantially, so to some extent it's being picked up there. And some basic and applied research has been shifted from the Defense Department to the National Science Foundation and the National Institutes of Health. But NIH has never been given the job of worrying about the biotech industry, for example, and that's not what NSF thinks it's for, either. What's missing is a branch of government to do exploratory development, strategic research to support the technical base of U.S. industry. In fact, that's what the Japanese call basic research. If you go to a Japanese university or company and say, "Show me the basic research," they'll point to three guys who yesterday invented a new opto-electronic device.

TR: So you think that the de facto U.S. science policy of the last 30 years—use the Defense Department as a driver of the fundamentals in technology and leave the commercial sector alone—will no longer work?

BRANSCOMB: That policy could certainly be improved. One alternative scenario would be for the Defense Department to expand its R&D investments and try to function as an explicit industrial-policy agency. For the ci-



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vilian economy to benefit from such a strategy, DOD would have to change the way it generates technology to make it more accessible to industry.

Another scenario is more attractive but politically more difficult to achieve. It says the Defense Department is a terribly expensive way to run an industrial-policy agency. A more sensible strategy is to fund a lean, mean Defense Department that buys a military force that can actually fight, and that relies as much as possible on a civilian industrial base. In that scenario you'd need a much-strengthened Department of Commerce to invest more heavily in the technology base.

BROOKS: Defense would be parasitic on the civilian economy rather than the other way around. You'd emphasize what's called "civil off-the-shelf technology," or COTS. Instead of telling contractors it's OK to build a parallel commercial version of a defense product, DOD would say, "The next time you make a commercial product, design me a defense version." It then would become terribly important for the government to devise effective trade and macroeconomic policies to maintain a strong economy.

BRANSCOMB: The model for that scenario is Japan. Suppose the Japanese wanted to build military products, how would they do it? The first thing they wouldn't do is go to all the generals and admirals and say, "Write me a 10,000-page requirements document." They would say, "Given the technology and manufacturing skills we have, what is the most economical and effective weapon we can build that lands somewhere in the ballpark of world requirements?" It's what's called spin-on.

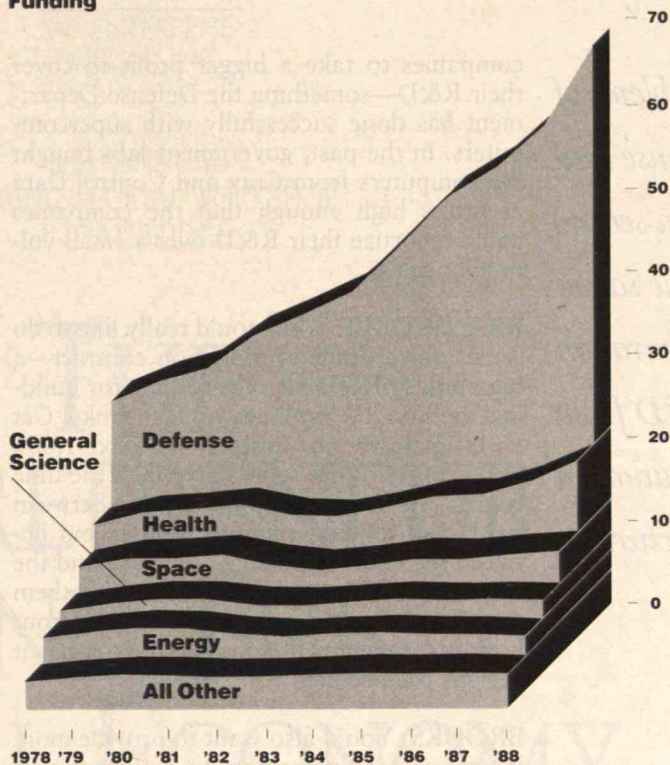
That strategy would also reduce the cost of most weapons. If the United States adopted that plan in the conventional-weapons business, we could make weapons that cost half, a fifth, a tenth as much. Of course, some unique military technologies would have to be developed specially—anti-submarine warfare could be an example.

But we're more likely to end up with a mixed strategy, where you try as much as possible for a shared technology base and rely on both spinoff from defense and spin-on from the commercial sector.

TR: Are we moving away from primary reliance on defense R&D with the creation, in last year's trade bill, of a new technology

Federal R&D Funding

\$ in Billions



undersecretary at Commerce?

BRANSCOMB: The money involved is insignificant, but it represents a fundamental shift in direction for the Commerce Department. It creates a framework for getting things done.

The change mainly involves expanding the National Bureau of Standards, renamed the National Institute for Standards in Technology (NIST). The bureau has always focused largely on research of value to industrial technology. It's a laboratory, not an agency in the traditional sense—it develops sophisticated methods for testing, diagnosis, and quality control that are of direct use to industry but that you need PhD scientists to do. A bill sponsored by Senator Glenn would actually have gone further and created a civilian DARPA. Still, the recent move puts diffusion of technology and promotion of productivity front and center as the bureau's main purpose.

TR: Given that the funds for the new agency will be limited, is there any way the Defense Department can make more effective use of its investment in civilian industry?

BROOKS: I would move much more in the direction of combining R&D and procurement. That means DOD has got to allow the

An alternative scenario says that defense should be parasitic on the civilian economy rather than the other way around.

*The problems of
the defense and
civilian sectors
are the same:
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of R&D from
innovation in
manufacturing.*

companies to take a bigger profit to cover their R&D—something the Defense Department has done successfully with supercomputers. In the past, government labs bought big computers from Cray and Control Data at prices high enough that the companies could amortize their R&D over a small volume of sales.

BRANSCOMB: What you'd really like to do is put out a limited-production contract—a big hunk of R&D plus the tooling for building the first 10 airplanes or 100 tanks. Get an estimate for the costs of the next 1,000 tanks, but bid that separately when the time comes. So the break point is not between R&D and the beginning of tooling, but between the end of limited production and the beginning of 10 more years of cranking them out. You force the company to think about how it's going to build something when it designs the product.

BROOKS: You'd also want to provide more incentives for contractors to trade off performance and cost. Now the military lays out its specifications in great detail and then has a bidding contest. There's little opportunity for companies to say, "If you cut this performance specification by 10 percent, we could give you an object that is 30 percent cheaper and that takes better advantage of civilian technology."

BRANSCOMB: The military should also make a massive effort to review its specifications—known as "milspecs"—in collaboration with NIST and industry. The objective should be to find all the cases where the milspecs are out of date or needlessly different from commercial standards, and try to tie military products to them.

BROOKS: A promising approach is to use alliances between companies to develop commercial and military computers simultaneously. For example, Digital came out with a new VAX computer at the same time that Raytheon announced a military version called MILVAX. The latter uses the architecture and theoretical principles developed by Digital but comes in an entirely different package with different specs and hardware. And the military version costs only about 30 to 40 percent more, whereas defense versions of civilian products often cost 5 or 10 times more.

The problem of dividing the R&D costs

for those two products didn't arise, since Digital didn't sell anything directly to the government. Its only benefit is the license fee from Raytheon when that company sells the product. I think we're going to see similar alliances as more and more of the cost of military systems stems from the electronics, which are often dual use—especially since the civilian market is so large compared with the military.

TR: Won't that mean the culture of the Defense Department will have to change significantly?

BRANSCOMB: Oh yes. It's too isolationist now. There's almost no interchange between commercial and military software, for example. One of the main reasons is that the services long ago standardized their computer languages. The Air Force, for example, buys software written only in Jovial, but no one in the commercial world programs in Jovial. Now DOD is trying to bring all the services together by using Ada, a new language, but that's not commercially popular either.

BROOKS: Software is one area where demands in the defense sector could stimulate the civilian market, since languages are very expensive to develop.

TR: Should the Defense Department take a lead role in coordinating such efforts?

BROOKS: No. Many of the two sectors' problems are the same—the separation of R&D from the rest of the innovation process is endemic in American industry. The one asset of the Defense Department is its ability to manage large technological projects. But it's no better—and probably not as good—at managing the transition to operations. One of the problems that delayed Sematech for so long was the Defense Department's insistence on exercising a strong technical management role.

Still, Sematech is in principle the right thing for the government to be doing—stimulating innovation in manufacturing processes. The big federal role should be in generic technology at a stage where the results can be widely shared. The only question is how any new technology the consortium develops will actually be used to create a healthy, self-sustaining industry that makes semiconductor-manufacturing equipment. ■



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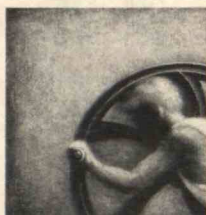
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Training the Workforce of the Future

NEARLY every diagnosis of the problems of U.S. manufacturing eventually comes around to the issue of

worker education and training. Employing new manufacturing technologies depends on the know-how of the people who use them. Responding to rapid changes in world markets requires workers who can learn new tasks and new roles quickly.

With this in mind, U.S. manufacturing companies are devoting increasing resources to improving the

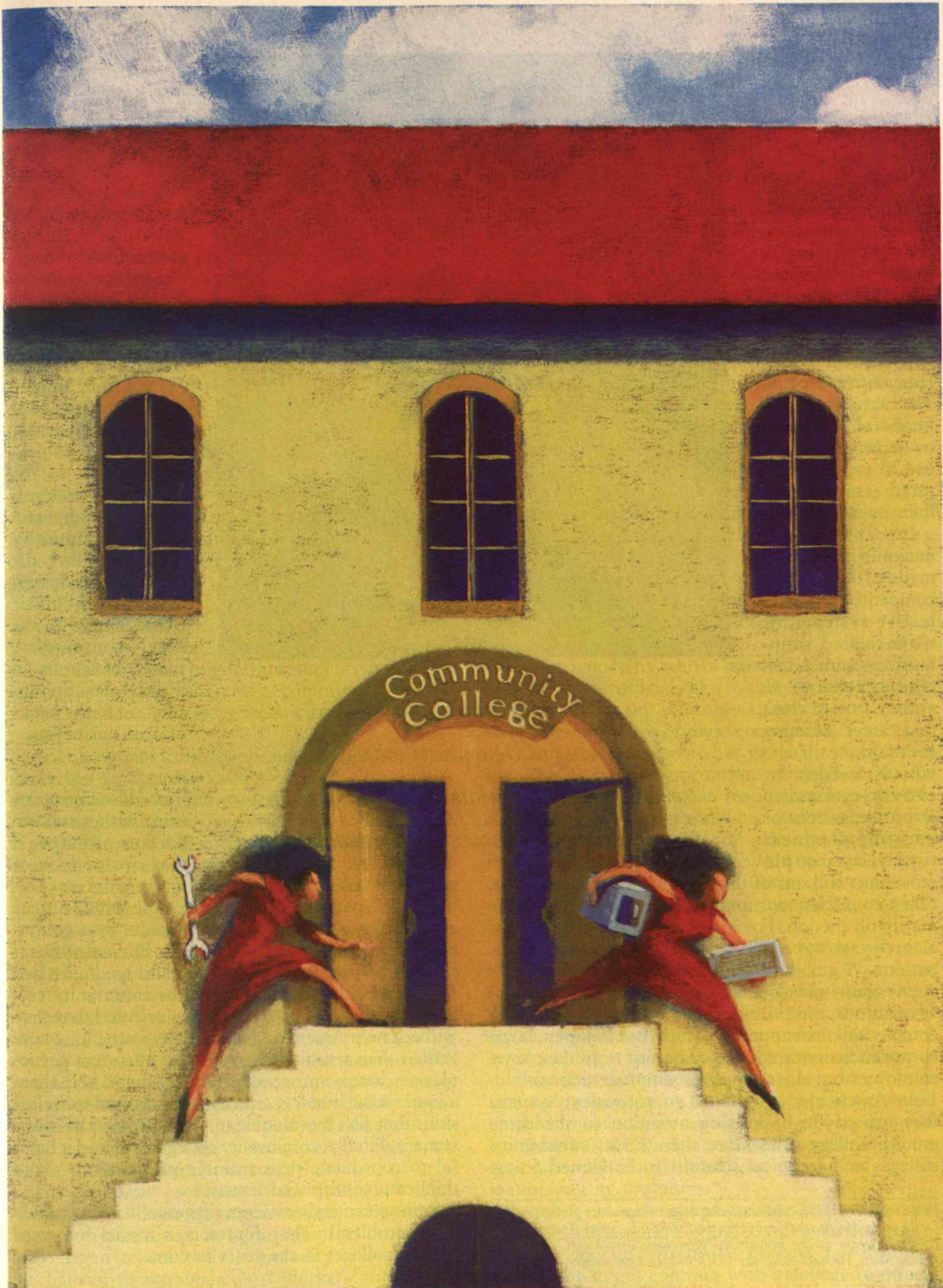
In the absence of a national policy for worker education and training, U.S. community colleges are trying to fill the gap.

skills of their workforce. The American Society of Training and Development estimates that private industry is spending more than

\$40 billion in this area every year. Major corporations such as General Motors, IBM, and Motorola have created sophisticated mechanisms to continuously train and retrain their employees.

Yet a crucial sector of the manufacturing workforce is not receiving the training it needs—the employees of the roughly 115,000 small and me-

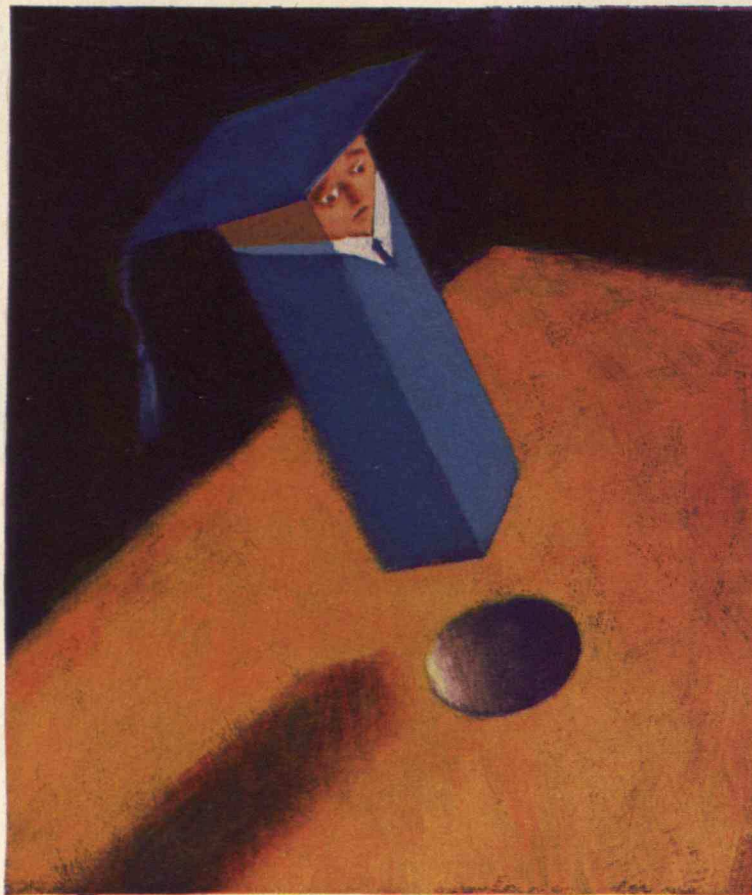
BY JAMES JACOBS



dium-sized firms. These companies, defined as having 20 to 499 workers, are critical because they tend to be the suppliers and subcontractors on which larger firms depend. They rarely have the financial resources or technical expertise to provide adequate training on their own.

In contrast, our nation's most formidable foreign competitors have effective systems for work-related training across the industrial spectrum. In some countries, mid-career training takes place in the schools. Sweden, for example, has an elaborate system of vocational education that people move into and out of throughout their work life. In other countries, occupational training occurs primarily on the job. For instance, West Germany has a three-year apprenticeship program in 400 occupations. A standard curriculum with national examinations—developed by government, employers' associations, and unions—certifies the successful completion of an apprenticeship. And in Japan, large corporations continuously train not only their own employees but their suppliers' employees as well.

As Americans search for an equivalent system, they are paying increasing attention to the community college. The more than 1,300 community colleges and technical schools in the United States



*The work-related
training at community colleges is
sometimes inappropriate because no one has
determined what jobs are in demand.*

are a ready-made network of public institutions for manufacturing education. Over half of first-year college students attend these schools. Even more important, occupational education has always been an important part of the community college's mission. Many faculty at community colleges come directly from industry. And because of their close ties with the local community, these schools are in a good position to respond to the needs of area businesses. However, community colleges have to come to grips with some important problems if they are to provide successful training for manufacturing workers. Too often, occupational programs at these schools focus exclusively on the needs of companies best able to pay for them—major corporations. But a significant number of people work in small and medium-sized firms. Also, the training programs community colleges offer tend to be so narrowly oriented that they will not help American productivity in the long run. Rather than teach workers how to operate a particular machine or process, programs should help them acquire basic literacy, critical thinking, and technical skills that will be valuable in a wide variety of work settings. Finally, community colleges will find it helpful to coordinate their training programs to avoid duplicating effort and resources.

Some recent experiments suggest a way to address these problems. They represent a model for community colleges in the years to come.

JAMES JACOBS has worked in the Michigan community-college system for 21 years. He currently manages the Public Education, Training, and Policy Program at the Industrial Technology Institute (ITI) in Ann Arbor, Mich. He also heads the ITI-Michigan Community College Liaison Office.

The Changing Community College

Vocational-education programs were first started in secondary schools. These programs involve a tightly structured set of courses—usually set off from liberal-arts and science tracks—that teach skills related to one particular occupation, such as automobile repair.

After World War II the proliferating community colleges also started to focus on vocational education. By integrating automated equipment such as pneumatic and hydraulic power tools on the assembly line, management was transforming mass-production industries like automobile manufacturing, eliminating many unskilled jobs. As a result, corporate executives, policymakers, and educators called for schooling to serve a more technically complex economy.

Whereas high school classes introduced students to entry-level work, community colleges concentrated on more skilled technical jobs. High school vocational education might train students to be medical receptionists, whereas a community college might graduate laboratory technicians or registered nurses.

As community colleges sprang up, they became the center for apprenticeship training for local business and industry. Sometimes they were incorporated into economic-development strategies. For example, in the South community colleges and technical schools were designed to expand the industrial base—in particular, to offer free job training to lure firms from the North.

By the 1970s, social changes that were causing community-college enrollments to mushroom were also changing the institutions' focus. Many new types of students—returning Vietnam veterans, laid-off industrial workers looking for jobs outside the manufacturing sector, and young people who couldn't afford four-year colleges—demanded a liberal-arts education. These programs grew rapidly alongside the traditional "voc-ed" curriculum but in isolation from it. Often occupational education became a backwater of the system, looked down upon by the growing liberal-arts staff.

The economic problems of the 1980s led many community colleges to return to their roots. States hard-hit by the recession in the manufacturing economy began to see their community colleges as a mechanism to retrain laid-off workers and attract

new plants. Companies started to view these schools as convenient places to purchase specific training programs.

In the Midwest, the trend received a major boost in 1982, when the United Automobile Workers (UAW) and management of the automobile industry set up joint funds for education and training. Each of the Big Three auto companies now puts 17 cents per worker per hour into the funds. In 1988, the UAW-GM fund received about \$150 million. Community colleges often provide the courses for which individual workers and local unions use the money.

With the fiscal crises and shrinking budgets facing most public institutions, community colleges have been only too happy to accept such funding and return their focus to work-related training. But the training programs in these schools are usually limited in important ways.

What's Wrong with Current Programs

One limit concerns who is taught. Although community-college officials like to talk about serving all workers, too many initiatives center almost exclusively on employees of major companies.

Other limits concern what is taught. Sometimes the schools offer inappropriate classes because no one has determined what manufacturing jobs are really needed. It is not the job of either administrators or teachers to take on these tasks. Nor is that the job of any other party in the community-college structure. As a result, research on industry trends is often done on an incomplete, ad-hoc basis.

For example, in the early 1980s community colleges across Michigan started providing courses in robotics. People streamed in, mistakenly assuming that because robots were causing layoffs, most workers would need to be robotics technicians. Community colleges rushed to offer additional classes in this area, but then it became clear that more robotics technicians were being trained than the state would need for the next two decades. By 1985 the demand for robotics courses declined significantly and most were abandoned or folded into general advanced-manufacturing programs.

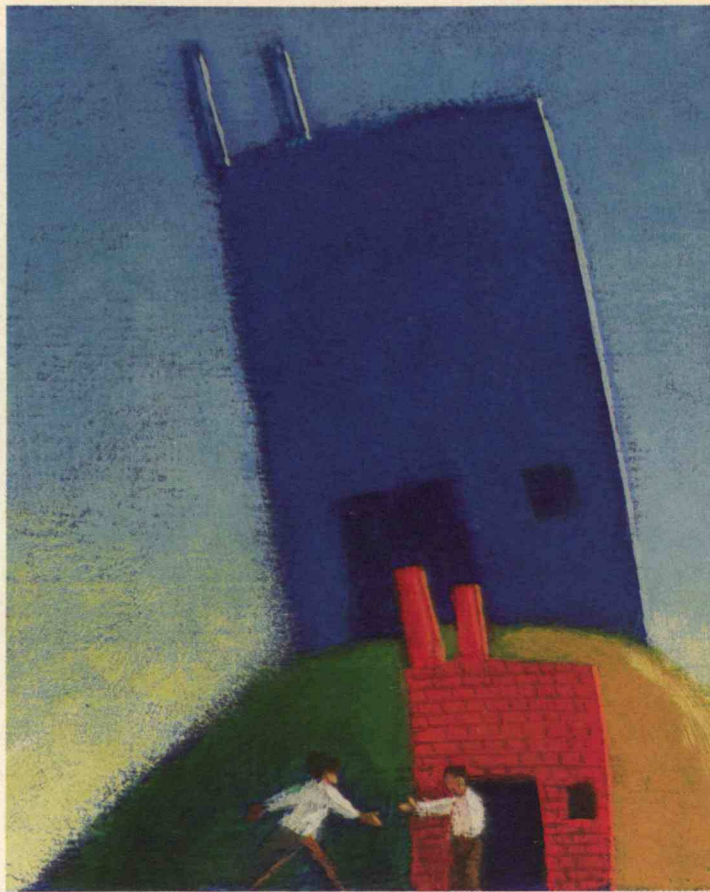
In other cases the subject matter has too narrow a technical orientation—how to run a particular machine or operate a particular process. For instance, a company might contract with a college to offer a

course on operating a four-axis turning mill, which is used in the metal-cutting industry. But today's workers need far broader skills, such as reasoning, communicating, and computing. The majority of employees have to perform complex problem-solving tasks, since machines and processes are computer-controlled.

Another common problem is that the subject matter is taught in an inappropriate way for workers. For example, while many liberal-arts faculty are teaching the critical-thinking skills increasingly necessary in jobs, their courses are often of little direct relevance to the workplace.

And many community-college teachers don't have the skills necessary to educate the modern workforce. Although most community colleges have recently spent large amounts of money on state-of-the-art manufacturing equipment, they have not developed staff who can program it—let alone teach students about it. The industrial experience of most staff predates the microcomputer.

Finally, many community-college teachers tend to approach supplementary technical training as they would traditional vocational education for students just out of high school. But what might be good for 18-year-olds looking for entry-level jobs is not appropriate for people in their mid-thirties, many of whom are already employed and come to class to improve their job status. These older students require programs that take factors such as their age and career aspirations into account.



*Community colleges should
provide training for small and medium-sized
manufacturers, who rarely have the resources to
develop adequate programs on their own.*

One State's Alternative

Some state community-college systems have tried to address these problems. In Michigan, the approach has been to link community colleges to the state's attempts to modernize the technology of small and medium-sized manufacturers—the “foundation firms” upon which major corporations like the Big Three automakers depend. More than 5,400 establishments in the state qualify as foundation firms. These companies employ over 500,000 people.

Foundation firms are tied to the local community; often

they are run by a single family. Usually they are committed to remaining in the state. Meanwhile, the manufacturing plants of large companies are relatively footloose, moving from one state to another or out of the country altogether in search of cheaper production.

To meet the training needs of foundation firms, Michigan's Industrial Technology Institute (ITI), a nonprofit research center for advanced manufacturing technology, includes a special liaison office for the community-college system. In 1986, the ITI Liaison Office, which I head, asked 200 state automotive suppliers about their needs for training employees and their use of new manufacturing technologies. The survey has found that companies adopt almost all such technologies exceedingly slowly, and that a major reason is the lack of training in engineering and management as well as on the shop floor.

Part of our response has been to establish a series

of workshops aimed at companies' joint union-management committees. The idea of the workshops, which are offered by community colleges, is to educate both labor and management about the key challenges of technological change. For example, many of today's firms would benefit from CAD-CAM software, which combines computer programs that design parts with those that operate machine tools. Yet small manufacturing companies often do not have the technical expertise to evaluate commercially available systems. Nor can they develop such systems on their own.

The survey has also found that companies want workers with basic thinking skills because such people can more readily handle equipment-specific training. But the firms also want education that addresses their particular concerns.

Thus, we learned the importance of developing courses that strike a balance between the specific and the general. Vocational classes at community colleges should emphasize skills that will be useful for a variety of jobs throughout an industry. Vocational educators at Michigan community colleges have taken this approach to develop literacy and computing courses related to situations workers face on the shop floor. And the Commerce Department has used the findings as it has hired community colleges to train employees at foundation firms that are adapting new technologies.

One course that is neither too narrow nor broad concerns statistical process control (SPC), a method of inspecting production goods through simple statistical sampling techniques. SPC permits workers to determine if parts are being manufactured properly, and enables people on the production line to solve problems when they crop up. In the mid-1980s, after the Japanese automobile industry had successfully implemented SPC, U.S. automakers started requiring all suppliers to develop extensive training programs in the technique.

This resulted in a major demand for SPC instruction among Michigan manufacturers. In 1984 the Governor's Office of Job Training—part of the Michigan Department of Labor—gave Jackson Community College a \$500,000 grant to train faculty at other community colleges how to teach a standard SPC course. All state community colleges have eventually offered the class.

Our office has found that this training is suited to many jobs in a key state industry. Moreover, work-

ers who have taken the course have not only increased their productivity and efficiency but have often gained the motivation to consider returning to school.

Another vocational-education class that is neither too specific nor too general is "cross-training," or teaching tradespeople a variety of skills so they can perform different functions. Cross-training has become increasingly important as computer-based technologies have required workers to understand an entire process. When a computer-controlled machine breaks down, for instance, workers have to know whether the problem is electronic or mechanical. My office has designed a cross-training course with a joint union-management training committee that represents a large steel plant.

Despite such initiatives, too many training programs continue to concentrate on big firms. From the perspective of the community-college president, it is far better to boast to your board of trustees that you served General Motors or General Electric than to say you helped the local stamper of small metal parts train two quality-control technicians.

And since much of the funding comes from commerce and labor departments rather than the state education bureaucracy, the Michigan programs are often quite separate from traditional vocational courses at community colleges. Therefore the benefits of staff development, including industrial contacts, don't spill over into traditional community-college education. This is still the case even though training efforts for people already on the job have increased by 56 percent during the past six years and conventional courses have declined slightly.

Beyond Individual States

In addition to the efforts of states like Michigan, community colleges are starting to join across state boundaries to establish regional training networks. This makes good economic sense because firms in specific manufacturing sectors usually cross state lines.

One network is the Mid-America Training Group, which consists of 15 community colleges located in major Midwest industrial centers such as Cleveland, Chicago, Milwaukee, Detroit, St. Louis, and Des Moines. The original strategy of the group—launched in the spring of 1985 through advertisements in the *Wall Street Journal*—was to market the

colleges' training resources to large companies throughout the Midwest. But so far, most clients of the group have been small manufacturers, which is probably for the best.

The Mid-America Training Group has used the diverse expertise of its participating institutions to avoid duplicating resources. In one case, a Michigan manufacturer wanted to learn how to use industrial lasers, so a local member college put it in touch with staff at Northcentral Technical School in Wausau, Wis. That school has expertise in this area, which is relatively specialized.

A regional approach to serving foundation firms is also being tried in the South. In 1988, the Southern Growth Policies Board, a nonprofit economic-development group, brought together 13 community colleges, one from each member state, in the Consortium for Manufacturing Competitiveness. Some participants in the group, such as Trident College in Charleston, S.C., and Gadsen State Community College in Gadsen, Ala., had already developed advanced technical-training centers. Others, mainly located in the rural South, had only started to work with a few industries.

The consortium is designed as an alternative to "smokestack-chasing" strategies that pit one state against another in wasteful economic competition. The group meets twice a year to help members develop curricula for their local manufacturers. At this point, each college is still working on its plans.

Such initiatives are promising, but without the coordination of a national program, it's likely that community-college systems will continue to reinvent the wheel, duplicating their already insufficient ef-



*With a national program to coordinate
worker-training, community colleges wouldn't
have to keep reinventing the wheel.*

forts on industry surveys. Furthermore, inequalities are likely to grow among community colleges, since not all states have substantial financial resources to support manufacturing industries. Another difficulty is that as we are finding in Michigan, state programs can't do much to discourage community colleges from focusing on big firms. Nor can they heal the split between traditional and customized vocational education.

A national program could solve these problems. It

could articulate what general technical skills workers need. And it could determine which industries are key to different regions. That would enable the regions to analyze the trends and specific training needs of these industries. A federal program also could stress the need for community colleges to employ researchers to thoroughly assess the picture.

Any national training effort also could use financial leverage to mandate that regions and states target small and medium-sized firms. Similarly, community colleges could be encouraged to link traditional and customized vocational education.

Finally, although training is necessary for a healthy manufacturing economy, it is not sufficient by itself. Federal training initiatives would have to be linked to a national employment policy. The nation needs mechanisms to help trained people find jobs.

Community colleges have long been an important route for working-class Americans who want jobs that ensure a modicum of economic security. And a broadly skilled workforce is essential for economic competitiveness and a stable democratic society. Thus, the future of U.S. community colleges could influence that of the country as a whole. ■

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Reviews

BOOKS

Technology's Nation

American Genesis: A Century of Invention and Technological Enthusiasm

by Thomas P. Hughes
The Viking Press, \$24.95

BY ROBERT HOWARD

In the opening of *American Genesis: A Century of Invention and Technological Enthusiasm*, historian Thomas P. Hughes makes a bold claim. As a history of technology, his book is not a narrow treatise outside the mainstream of American history. Rather, it is "an exploration of the American nation involved in its most characteristic activity." The United States, quite unlike any other society, Hughes argues, is "technology's nation."

American Genesis is a wide-ranging and fascinating study of how in the hundred years after 1870, Americans created a set of technological systems that shaped our society and the entire world. Hughes, whose previous books include a biography of the engineer-inventor Elmer Sperry and a history of electrification, draws on recent research in the history of technology. He brings together a broad range of materials and information in a fresh and original way.

But the strength of *American Genesis* as synthesis masks a weakness as historical analysis. Hughes never adequately answers a basic question: why did technology reach such a full expression in this particular society and at this particular time?

From Edison to the Challenger Disaster

By "technology," Hughes means far more than the electric light, radio and television, airplane, or automobile. Such well-known artifacts are "embedded in systems of people and organization." The electric light depends on a vast network of coal-burning, hydroelectric, and nuclear power stations, on power lines, and on the utilities that control them. The automobile rests on a complex system of manufacturing, interstate highways, and petroleum refineries.

American Genesis describes the people and organizations that created this technological world and, in particular, the "drive for order, system, and control" that impelled

them. The story begins with the independent inventors of the late nineteenth century. Figures like Edison and Bell not only laid the groundwork for the technological systems of the twentieth century; they were lionized by the public, setting a pattern for the social celebration of technology that would long outlive them.

By the early twentieth century, the impetus for technological creativity had shifted from the independent inventors to industrial R&D labs at corporations such as Du Pont, General Electric, and AT&T. There, company scientists, with the help of astute patent lawyers, harnessed the invention process to the engine of corporate profit. Later, "system builders"—Ford and his assembly line, Samuel Insull and his electric power networks, and Frederick Winslow Taylor with his program of scientific management—extended the principles of "order, system, and control" to vast hierarchies of people and technology.

Hughes also relates how these systems transformed the industrialized world. Europeans wholeheartedly embraced American technology and its principles in the years after World War I—a phenomenon Hughes terms "the second discovery of America." In Weimar Germany, labor leaders and managers, liberals and conservatives, saw the principles of the assembly line and scientific management (known in German as *Fordismus* and *Taylorismus*) as the keys to economic and social reconstruction. They idealized labor relations at Ford's River Rouge plant much as Americans idealize Japanese labor relations today.

In the Soviet Union, Lenin thought that scientific management would fuel the transition from capitalism to socialism. The country's forced march into industrialization in the 1920s and '30s was founded almost entirely on Western technology. During the building of the Dnieprostroy dam, then the largest hydroelectric station in the world, about 70 percent of the generating equipment and all the steam shovels, hoists, locomotives, rock drills, and construction steel were American. So was the chief consulting engineer.

European artists, inspired by what they saw as America's technological dynamism and cultural modernity, celebrated technology in movements such as Russian constructivism, Italian futurism, Dadaism, and the international style in architecture. Paradoxically, these movements were a crucial source of new images and techniques for a generation of American artists that included Alfred

Steiglitz, Charles Sheeler, Charles Demuth, and Joseph Stella.

American technological systems reached their apex in vast government-administered programs of the 1930s, '40s, and '50s: the Tennessee Valley Authority and the military-industrial complex that created the atomic bomb and applied nuclear energy for both military and civilian uses. But even as American technology seemed to achieve its greatest triumph, it began to engender a deep-felt counterreaction. By the 1960s, counterculture critics were attacking "the system." And in the 1970s and '80s, environmental problems, the accident at Three Mile Island, and the *Challenger* disaster fueled widespread public doubts about technology.

Today, Hughes argues, American society faces a standoff. On the one hand, centralized systems seem increasingly unable to adapt to the new challenges of global economic competition and ongoing environmental degradation (witness the difficulties of U.S. mass-production industries and the growing crisis of petroleum-based transportation). On the other hand, these systems and the people who depend on them still have considerable momentum and power. Whatever the outcome, it is hard to imagine that technology will have the same pride of place in our society during the next hundred years that it enjoyed in the last.

A Human Longing?

Despite its broad scope and wealth of detail, there is something missing in *American Genesis*. Although Hughes rejects technological determinism and insists that technology is "socially constructed," he never really explores the underlying factors that made America technology's nation.

At times, he seems to assume that the drive for order, system, and control was a response to rapid economic and social changes brought by industrialization and urbanization. In a statement reminiscent of Robert Wiebe's classic *The Search for Order*, he says his inventors, engineers, industrial scientists, and system builders were "uneasy in a seemingly chaotic and purposeless world." Thus the irony of Edison, whose electric lighting transformed the American city, retreating to his workshop in pastoral Menlo Park, N.J.; and Ford, the creator of the mass-production assembly line, spending the last years of his life building the Greenfield Village museum, a paean to small-town America.

At other moments, Hughes seems to lean toward a more psychological interpreta-

tion—that technology's nation sprang from deep internal drives. He talks about a "fundamental human longing" for order and control, speculates that in their childhood and adolescence many inventors "had encountered a world that disappointed them," and twice refers to Henry Ford's "fixation" on the concept of "smooth flow."

Both these explanations (which need not be mutually exclusive) are intriguing. But Hughes never develops either in any depth. As a result, his story seems to hang in midair. The systems he describes appear isolated from the social, economic, cultural, and psychological factors shaping them.

Still, *American Genesis* is an important work. It is a summation of what we know about technology and its role in the modern world and a starting point for others to probe more deeply its place in our lives. ■

ROBERT HOWARD is a senior editor of Technology Review.



BOOKS

Debunking the Genetic Myth

Genethics: The Clash Between the New Genetics and Human Values

by David Suzuki and Peter Knudtson
Harvard University Press, \$25.00

BY PAUL BILLINGS

Ever since Francis Galton, the cousin of Charles Darwin, coined the term "eugenics" in the late nineteenth century, the idea that discoveries in genetics could be used to improve the human species has exercised a continuing fascination. Even today, as people look back in horror at the enforced sterilization of so-called hereditary defectives in the 1930s and the "racial-hygiene" policies of the Nazis, the allure of eugenics persists. Recently in *Scientific American*, Harvard professor Richard Herrnstein proposed a genetic explanation for America's economic decline: smart people are not procreating as frequently as others, thus causing society's collective IQ to drop.

The myth of genetic perfection has been given new life by the contemporary revolution of molecular biology. The remarkable ability to mass-produce copies of DNA se-

quences and insert them into any living thing has, in the past decade, raised the specter of the universal "improvement" of life once again. Biotechnology firms bank that a DNA splice here and an insertion of a new gene there will end blight, cure common ailments, and provide stockholders with a hefty profit. Even our deficit-ridden national government is willing to gamble billions of dollars to sequence the human genome.

How will we prevent this well-financed revolution with a tawdry past from getting out of hand? In *Genethics: The Clash Between the New Genetics and Human Values*, geneticist David Suzuki and science-writer Peter Knudtson offer "a comprehensive set of moral guidelines for genetic responsibility"—a code of "genethics," as they call it, to ensure that the new discoveries do not become mechanisms of social and political abuse.

Frenetic Genetics

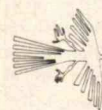
Genethics is really two books in one. The first is a popular explication of modern genetics, with examples drawn largely from bacterial and plant studies. Throughout, the authors discuss experiments and make observations in a breezy style—much in the manner of science writing popularized by Lewis Thomas, Stephen Jay Gould, and Oliver Sacks. Unfortunately, too-cute phrases like the "dance" of genetics, "glistening" DNA, and "fragile" genetic lineages are



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- Abner Doubleday did not invent baseball at Cooperstown—or anywhere else in America
- London's Big Ben is neither a clock nor a tower
- Robert Fulton did not invent the steamboat, and the boat he built was not called the Clermont
- Scores of people had flown nonstop across the Atlantic before Lindbergh
- No witches were burned at Salem
- Edison did not invent the lightbulb
- Conan Doyle's Sherlock Holmes never said, "Elementary, my dear Watson"
- Mark Twain was not born in Hannibal, Missouri
- And, alas, there is no such thing as an aphrodisiac

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so relentlessly colloquial that they are difficult to take seriously.

The second half of the book provides case studies of genetic applications and the "genetic" principles they illustrate. One example is the attempt to link certain genetic traits with complex human behaviors like criminality. This leads the authors to formulate a principle that since "the vast majority of human hereditary differences are polygenic"—involving many genes—"it is a dangerous simplification to proclaim a causal relationship between human behaviors and so-called 'defects' in human DNA." Problems with genetic screening in the workplace elicit another genetic prin-

ciple: "Information about an individual's genetic constitution ought to be used to inform his or her personal decisions rather than to impose them."

Most of these principles are sound, and Suzuki and Knudtson rightly emphasize that the frenetic pace of the genetic revolution in the last 10 years has allowed little time for scientific or ethical reflection. The findings of the new genetics, like those of all science, must undergo review and replication before they are applied. Most published science is incorrect or not important. It fades without effect. The new questions and limited truths that good experiments generate must be winnowed from the dead ends of the bad. Unfortunately, business, government, and the public tend to latch on to every new bit of genetic research as the answer to some social or medical problem. As a result, preliminary findings are given premature importance, and poor science tends to persist.

In Search of a New Mythology

Taken as a whole, *Genethics* is less satisfying than its many parts. The authors never make clear why we need such principles or how they might be applied.

One of the reasons Galton's dream has proved so difficult to repudiate is our distinctly human urge to explain life's miseries and mysteries by blaming our ancestors. When life gets tough, we resort to the determinism and fatalism of heredity. It is easier to posit a genetic cause for birth defects than to understand and do something about the cultural and political factors that cause malnourishment among poor mothers. It is easier to screen genetically susceptible workers from certain jobs than to clean up polluted workplaces. Because they never address this human tendency, Suzuki and Knudtson never clearly establish why the misuse of genetic research is a persistent danger.

Nor do the authors go into detail about the specific choices we face in the near future. What are the risks of the way we develop and control genetics? How are those risks balanced against benefits, especially to those suffering from inherited diseases? What changes are we willing to make to improve crop yields or produce more life-saving antibiotics? To answer such questions, we need a more pragmatic assessment of the ethical quandaries now facing geneticists. The authors' vagueness on this score weakens their arguments in favor of restraint.

Finally, *Genethics* is flawed by Suzuki and Knudtson's conclusion that only a "new



mythology," incorporating "non-Western moral sources" beyond the "rigid boundaries of Western science and even Western philosophical thought," can address the ethical dilemmas in genetics. It is unclear how Hinduism will help when someone cannot get a job because schizophrenia seems to run in his or her family, or when the insurance company will not pay for the care of a child whose mother had refused to abort it, even though she knew it had cystic fibrosis.

The fact is, the current efforts to expand genetics will inevitably bring change—and at a price. Witness disabled people who are already discriminated against, or even the worried parents who wonder whether their child will be not just normal but chromosomally perfect—all because of a lab test unavailable a generation ago. This places a heavy burden of responsibility on geneticists for carefully applying the revolution in genetic technology, and makes the grandiosity that has plagued genetics since Galton more dangerous than ever before.

Though Suzuki and Knudtson's book does not provide a recipe for making genetics more ethical, it contributes to opening society's eyes to the implications of the new genetics. If it succeeds in engendering a little realism and humility among geneticists and enlightening a larger audience, then it will have been worthwhile. ■

PAUL BILLINGS is director of the Clinic for Inherited Diseases at New England Deaconess Hospital and instructor in medicine at the Harvard Medical School.



The author responds:

My objection to the case Fought and Rector make is simple: nuclear weapons. It is just plain irresponsible to make academic plans about military strategies without considering the implications of such capability. These letter writers should pay more attention to their boss, Adm. Carlisle Trost, who calls for more "sapience" in future naval warfare. This means that "human beings must be in the operational loop as close to the point of application of power as the situation will permit," he says. He adds that so far, no technology anyone has conceived is "capable of substituting for the imagination, judgment, total comprehension, will to resist, and ethical standards of a human warrior." Nuclear weapons are clearly the antithesis of sapience: they remove humans from the loop and nullify traditional military strategies.

Also, it is politically absurd to spin out fanciful scenarios about how nuclear weapons could be called upon to do the dirty jobs if conventional arms turn out not to be good enough. We could never use nuclear weapons, even if we were losing a war, because if we did, we would really lose. Arguing about arms control, frankly, is boring. Our first responsibility is to address issues of security that may be threatened by our peacetime practices, our crisis-management plans, or our war plans as practiced during peacetime.

In this regard, it is worth noting that the purpose of the maritime strategy is rather ambiguous. On the one hand, Fought and Rector have accepted it as the best deterrent against the might of the Soviet Union, but on the other hand, they want to portray it as a tragic and necessary defense of our interests in general.

Furthermore, we are to believe that if deterrence against the Soviets were to fail, the maritime strategy contains the best tactics for defeating them. But when does war actually start in the minds of the war gamers? Are all of the practice runs, tough words, new weapons, and aggressive cruises near Soviet home waters intended only to deter war? Or are they explicit previews of what would happen when war broke out? When would forces actually move forward? If a cri-

sis occurred, would they do it then? Is that war? If U.S. and Soviet allies went to war, would that be war? If U.S. and Soviet forces mobilized in the Indian Ocean to deal with a Persian Gulf conflict, or the eastern Mediterranean Sea to deal with the Middle East, or the Caribbean to deal with Central America or Cuba, would that be war? When would the maritime strategy be implemented?

The Navy says national leaders would decide, and that preparations to implement the maritime strategy would signal to the Soviets that their territory would not be a sanctuary. But wouldn't this be the quickest avenue for escalation to strategic nuclear war? Moreover, does anyone at the national level tell the Navy *not* to move?

It seems that the maritime strategy needs more homework, and this is a job for those who think beyond the naval mission. Unfortunately, most analysts have shown little evidence of fundamental thought about the proper tactics for our military forces. That kind of thought would take into account the

Soviets' reduced naval and military activity, decreased ship production, and circumspect naval operations. We should ask whether our peacetime military exercises are consistent with the degree of deterrence needed, and whether these exercises actually represent our national strategy.

Most importantly, we should bear in mind that naval supremacy isn't the point. Security is. If naval supremacy needs to be abandoned to achieve a greater measure of security, then it should be. If maritime forces are a part of overall forces, then they should be so counted, in calculations of the military balance and in arms-control solutions. And long-range naval nuclear weapons should be seen solely in the context of their function, which is strategic strikes on the Soviet Union. That is, naval nuclear weapons should be counted as strategic until they are eliminated altogether. I may not have the design for a perfect alternative force structure. But it behooves the scholars at the naval war college to think beyond the current standoff, and beyond a world with nuclear weapons.

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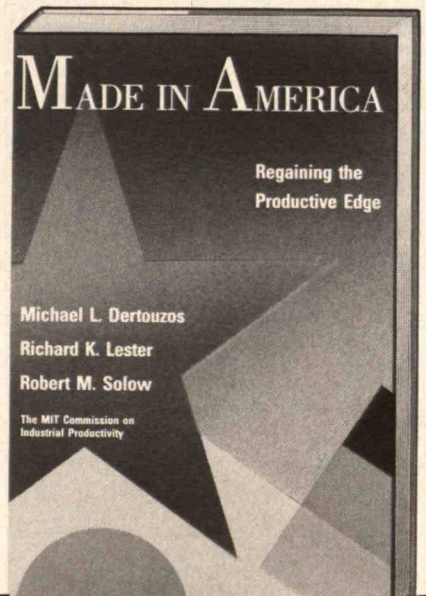
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What's more, solving the problem by governmental regulation would be a cure worse than the disease. While minor abuses might be uncovered by persistent and aggressive investigations, the end result would be a chilling of scientific research. Pathfinding science often involves a creative leap, an understanding that goes beyond the data to reach an intuited truth. In the most creative science, conclusions that are often only supported weakly by the original data stand or fall by the greatest test—experimental verification by others. Rigid government oversight could produce a system where, out of fear of retribution, scientists perform only safe, conservative experiments.

Disrupting the Scientific Method

Authors of scientific papers risk everything when they publish their work. If a researcher develops a reputation for error, other scientists scrutinize his or her work all the more closely. And because funding decisions are made on the basis of peer review, error-prone scientists soon lose their financial support and are no longer able to function. This process is the ultimate safeguard against errors, whether they are consciously perpetrated or not.

The battle I have been fighting is for my reputation and that of my colleagues. It is also for the right of scientists to determine their own style and direction without political interference and to be judged by their peers on the merit of the science. The efforts of self-styled auditors to judge a given piece of research will only disrupt the orderly progress of science. ■



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MIT Reporter

Growing Livers for Transplants

Taking advantage of humans' ability to regenerate most organs could end the organ shortage for many transplant operations. Robert S. Langer, MIT professor of chemical and biochemical engineering, and Joseph P. Vacanti, M.D., director of the Liver Transplant Program at the Boston Children's Hospital, are developing a technique that would allow them to use only a fraction of a donor's liver for transplantation.

Knowing that a human can regenerate a partly removed liver, Langer and Vacanti are mounting liver cells on polymer mesh and treating them with enzymes. The researchers hope to grow these cells to about 10 percent of the mass of a whole liver. Then they would transplant the regenerating body part plus the biodegradable polymer mesh into a patient. In several weeks the liver would be fully grown, and would take over for the original liver.

The technique would relieve the shortage problem because small slices of livers could be removed from living donors. And better matches between donors and patients would be possible. As for the operations, those for donors—who most likely would be close relatives of the patient—would probably be less intrusive than a common kidney transplant, says Linda Cima, an MIT postdoc in charge of the chemical engineering aspects of the project. For recipients, the operations would be "far simpler" than current transplants, Vacanti says. The surgery would not be as complex.

While their work is at a preliminary stage, Langer says the researchers have had some "short-term promising results in animals."

David and Goliath in Space

Japan's space program is the David of the space scene, while the U.S. effort is the Goliath, says Daniel Hastings, associate professor in MIT's Department of Aeronautics and Astronautics. Despite NASA's enormous success, it has become a huge bureaucracy without a clear sense of direction over the long run. The two counterpart agencies in Japan are lean yet forging ahead into long-term work.

NASA's finances are nine times those of



the Japanese space agencies, but the U.S. agency is hostage to short-term funding dished out by Congress, Hastings says. To make the most of this situation, NASA puts its efforts largely into prestigious projects that garner generous government support, such as the *Apollo* mission and the space shuttle. Hastings observes that the agency also gives a low estimate of project costs when requesting funds, in fear that programs will otherwise be turned down.

When budget crises ensue, funds from NASA projects that aren't as politically attractive at the time are easily raided, and those efforts are canceled. Sometimes the agency halts useful projects for others it thinks will command more interest. In either case, much scientific know-how then goes by the board. Witness the fate of the powerful Saturn V rockets, which went out of production after they were used to put astronauts on the moon. Without these rockets, the payloads that the United States can put into space are smaller.

When interest in abandoned programs is rekindled, scientists have to reinvent the wheel. In the early 1980s NASA cut back funding for developing high-voltage solar arrays, which it now needs to power the space station.

To ensure that funding for its various space projects can't be easily raided if money gets tight, Japan has divided its space efforts between two agencies. ISAS conducts research, and NASDA focuses on development. The two agencies are more realistic about their financial needs from

Leonard Dowdy (right), deaf and blind since infancy, uses his sense of touch to understand the speech of Douglas Henderson (left), a research assistant at the MIT Research Laboratory of Electronics. Henderson is studying this technique,

known as Taddoma, to develop a device that would convert sounds to movements felt on the skin. The model skull, which several scientists in the lab use for such research, has movable lips and jaw and oral air flow. And its larynx can vibrate.

the start, so cost overruns are rare. The Japanese parliament also shows more interest in funding long-term programs, many of which are less flashy than those of NASA, Hastings says.

This approach yields impressive results. ISAS has launched *Ginga*, the world's only working x-ray telescope, and two satellite flybys of Halley's comet. It intends to put one satellite a year in orbit to maintain a steady flow of research results. Since NASDA aims to become autonomous in launching ability as well, it is developing boosters comparable to those of the United States for putting payloads in geosynchronous orbit. For example, plans for a space plane are in the works. After the turn of the century, the agency hopes to establish its own space station for materials processing.

Hastings contends that because of their differences, the two countries would benefit from cooperating in space.



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